CONSUMER ELECTRONICS SHOW ROUNDUP

MAY 1998

Electronics NOW®

uild a
Swipe-Card Reader
eep your secrets safe
rom prying eyes

et the
ig Picture
rge-screen TVs that
u can hang on a
all are finally here

uel-Cell-Powered ars and Buses
ill they someday replace
day's polluting vehicles?

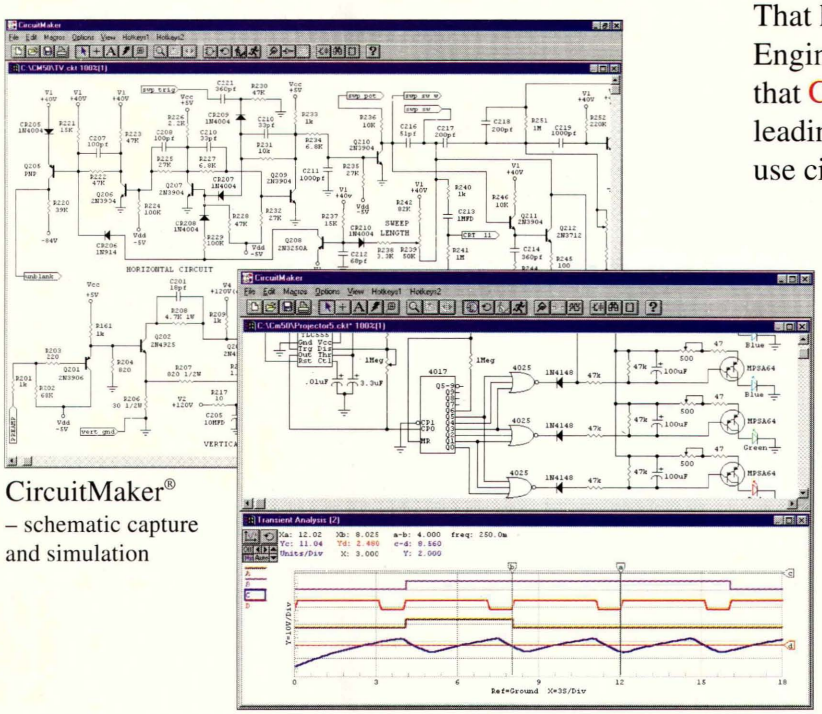
uild a
igital Storage scilloscope
rn any PC into
high-powered
orage scope

A GERNSBACK PUBLICATION

$4.50 U.S.
$4.99 CAN.

Professional Power

at a hobbyist price.



CircuitMaker®
– schematic capture
and simulation

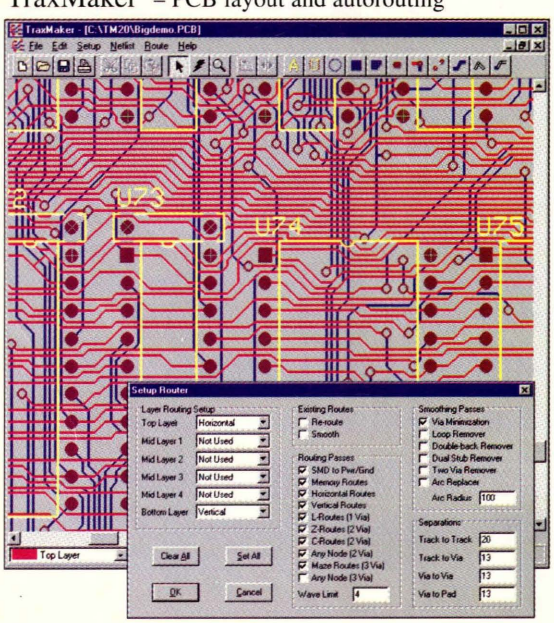
That has been our philosophy at MicroCode Engineering since 1987. So it's no surprise that CircuitMaker and TraxMaker are the leading software tools for affordable, easy-to-use circuit design, simulation and PCB layout.

QUICKLY DESIGN analog, digital or mixed analog/digital circuits with CircuitMaker's advanced schematic features. You fully control the wiring, device placement, annotation and colors. And the Symbol Editor and macro features let you create unlimited custom devices and symbols.

SIMULATE and **ANALYZE** what you create – try all the "what if" scenarios with:

- Fast, proven 32-bit SPICE 3f5/XSpice simulator
- True mixed analog/digital simulation
- Fully interactive digital logic simulation
- 4,000-device library
- AC Frequency Analysis
- DC Operating Point Analysis
- DC Transfer Function
- Transient Analysis
- Step Function – step component values and sources over a user-definable range

TraxMaker® – PCB layout and autorouting



TAKE MEASUREMENTS at any point in the circuit with a click of the Probe tool. Results appear immediately on virtual instruments like the Digital Oscilloscope, Curve Tracer, Digital Multimeter and Bode Plotter. No other simulator lets you take measurements as quickly and easily as CircuitMaker.

COMPLETE the design process with TraxMaker, a professional printed circuit board layout program with built-in autorouter. Import netlists from CircuitMaker and other schematic programs, or design boards from scratch.

- Includes autorouter, auto component placement and Design Rules Check
- Supports up to 8 copper layers, board sizes up to 32 x 32 inches
- Surface mount and through-hole components from a customizable library
- Outputs your PCB as a Gerber file, Excellon N/C drill file, and prints to any Windows-selectable printer or plotter

RELY ON free technical support from qualified engineers. And every MicroCode product is backed by our **30-day Money-Back Guarantee** if it does not live up to your expectations.

Call 800-419-4242 for more information and free demos

(or download from www.microcode.com)

CIRCLE 171 ON FREE INFORMATION CARD

CircuitMaker Version 5	**$299**
TraxMaker Version 2	**$299**
CircuitMaker Design Suite™ (CircuitMaker and TraxMaker)	**$549**

MicroCode Engineering Inc • 927 W. Center St • Orem, UT 84057 • 801-226-4470 • Fax: 801-226-6532 • Email:sales@microcode.com

CIRCLE 133 ON FREE INFORMATION CARD

Electronics NOW®

Vol. 69 No. 5

CONTENTS

MAY 1998

ON THE COVER

37 BUILD THE INFOCARD CARD SCANNER

We've seen them in airports, office buildings, laboratories, and anywhere else where it is important to restrict access to any area to only those who have legitimate business there. We've also used them on an almost daily basis to gain access to our money at an ATM and even to buy groceries or gas. What we are talking about are the now ubiquitous swipe cards that are used to provide an extra measure of security to people, places, and information. In this month's cover story, we'll show you how to add that same type of security with a system that can be integrated with computers, locks, and more. — *J. J. Barbarello*

TECHNOLOGY

13 PROTOTYPE

Consumer Electronics Show roundup and a look at how the new large-screen, flat TVs work.

50 FUEL-CELL-POWERED VEHICLES

Are fuel cells the technology that will replace today's polluting internal-combustion engine? — *Bill Siuru*

54 NATIONAL ELECTRONICS TECHNICIANS DAY 1998

It's a time to honor those who have shown a commitment to the electronics-servicing profession, and an opportunity to join their ranks. — *Alice Brown*

As a service to readers, ELECTRONICS NOW publishes available plans or information relating to newsworthy products, techniques and scientific and technological developments. Because of possible variances in the quality and condition of materials and workmanship used by readers, ELECTRONICS NOW disclaims any responsibility for the safe and proper functioning of reader-built projects based upon or from plans or information published in this magazine.

Since some of the equipment and circuitry in ELECTRONICS NOW may relate to or be covered by U.S. patents, ELECTRONICS NOW disclaims any liability for the infringement of such patents by the making, using, or selling of any such equipment or circuitry, and suggests that anyone interested in such projects consult a patent attorney.

ELECTRONICS NOW, (ISSN 1067-9294) May 1998. Published monthly by Gernsback Publications, Inc., 500 Bi-County Boulevard, Farmingdale, NY 11735-3931. Periodicals Postage paid at Farmingdale, NY and additional mailing offices. Canada Post IPM Agreement No. 334103, authorized at Mississauga, Canada. One-year subscription rate U.S.A. and possessions $19.97, Canada $27.79 (includes G.S.T. Canadian Goods and Services Tax, Registration No. R125166280), all other countries $28.97. All subscription orders payable in U.S.A. funds only, via international postal money order or check drawn on a U.S.A. bank. Single copies $4.50. © 1998 by Gernsback Publications, Inc. All rights reserved. Printed in U.S.A.

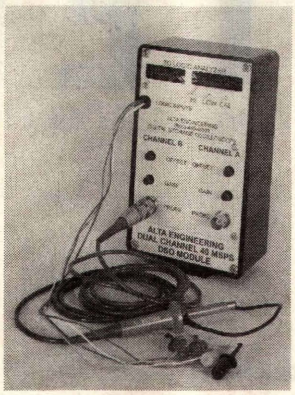
POSTMASTER: Please send address changes to ELECTRONICS NOW, Subscription Dept., Box 55115, Boulder, CO 80328-5115.

A stamped self-address envelope must accompany all submitted manuscripts and/or artwork or photographs if their return is desired should they be rejected. We disclaim any responsibility for the loss or damage of manuscripts and/or artwork or photographs while in our possession or otherwise.

MAY 1998

BUILD THIS

43 BUILD A DIGITAL STORAGE OSCILLOSCOPE
Combine this add-on module, the High-Performance Logic Analyzer from last March's issue, and almost any PC, and get a powerful digital storage scope for your workbench.
— *Robert G. Brown*



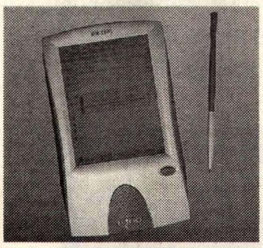
DEPARTMENTS

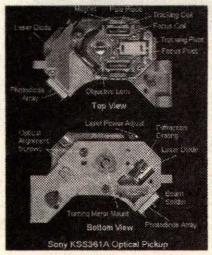
10 COMPUTER CONNECTIONS
The platform is the user interface. — *Jeff Holtzman*

22 EQUIPMENT REPORT
Fluke Model 77 III digital multimeter.

23 SERVICE CLINIC
CD information storage and playback. — *Sam Goldwasser*

57 TECH MUSINGS
The right way to measure AC power. — *Don Lancaster*





AND MORE

4 EDITORIAL
5 LETTERS
6 Q&A
27 NEW PRODUCTS
31 NEW LITERATURE
110 ADVERTISING INDEX
110 ADVERTISING SALES OFFICE

Electronics NOW®

Hugo Gernsback (1884-1967) founder

LARRY STECKLER, EHF, CET, Editor-in-chief and publisher
ADRIA COREN, Vice-President
KEN COREN, Vice-President

EDITORIAL DEPARTMENT
CARL LARON, editor
JOSEPH J. SUDA, technical editor
JULIAN S. MARTIN, associate editor
EVELYN ROSE, assistant editor
TERI SCADUTO, assistant editor
MICHAEL A. COVINGTON, N4TMI contributing editor
SAM GOLDWASSER, service editor
JEFFREY K. HOLTZMAN, computer editor
FRANKLIN J. MILLER, audio editor
DON LANCASTER, contributing editor
DEBBIE CYBULA, editorial assistant

ART DEPARTMENT
ANDRE DUZANT, art director
RUSSELL C. TRUELSON, illustrator

PRODUCTION DEPARTMENT
RUBY M. YEE, production director
KATHRYN R. CAMPBELL, production assistant
KEN COREN, desktop production director
LISA BAYNON, desktop production
MELISSA GIORDANO, desktop production

CIRCULATION DEPARTMENT
THERESA LOMBARDO, circulation manager
GINA GALLO, circulation assistant

REPRINT DEPARTMENT
CHRISTINA M. ESTRADA, reprint bookstore

Typography by Mates Graphics

Electronics Now is indexed in *Applied Science & Technology Index*, and *Readers Guide to Periodical Literature*, *Academic Abstracts*, and *Magazine Article Summaries*.
Microfilm & Microfiche editions are available. Contact reprint bookstore for details.

Advertising Sales Offices listed on page 110.

Electronics Now Executive and Administrative Offices
1-516-293-3000.

Subscriber Customer Service:
1-800-999-7139.
7:00 AM–6:00 PM Monday–Friday MST

VISIT US ON THE INTERNET AT:
www.gernsback.com

Audit Bureau of Circulations
Member

Take This Giant Circuit Library

For Only $4.95

when you join the
Electronics Engineers' Book Club®

Hundreds of circuit ideas alphabetically arranged-from Alarm circuits to Zero crossing detector circuits!

"...includes schematics for the latest electronics circuits from industry leaders..."—**Popular Electronics**

The Encyclopedia of Electronic Circuits Volumes 1-3
by Rudolf F. Graf

2,344 total pages
3,490 total illustrations

Turn to this comprehensive circuit library for hundreds of project ideas...valuable troubleshooting and repair tips...and concise pinout diagrams and schematics. Each volume contains more than 700 electronic and integrated circuits and covers 100+ circuit categories.

If coupon is missing, write to:

Electronics Engineers' Book Club®, *A Division of The McGraw-Hill Companies,* P.O. Box 549, Blacklick, OH 43004-0549

Phone: 1-614-759-3666 (8:30 am to 5:00 pm EST Monday-Friday) **Fax: 1-614-759-3749** (24 hours a day, 7 days a week)

Internet: www.bookclubs.mcgraw-hill.com

As a member of the Electronics Engineers' Book Club...

you'll enjoy receiving Club bulletins every 3-4 weeks containing exciting offers on the latest books in the field at savings of up to 50% off the regular publishers' prices. If you want the Main Selection, do nothing and it will be shipped automatically. If you want another book, or no book at all, simply return the reply form to us by the date specified. You'll have at least 10 days to decide. If you ever receive a book you don't want due to late delivery of the bulletin, you can return it at our expense. Your only obligation is to purchase 2 more books during the next 12 months, after which you may cancel your membership at any time. And you'll be eligible for FREE BOOKS through our Bonus Book Program.

Publishers' Prices Shown © 1998 EEBC

ELECTRONICS ENGINEERS' BOOK CLUB®

A Division of The McGraw-Hill Companies, P.O. Box 549, Blacklick, OH 43004-9918

❑**YES!** Please send me *The Encyclopedia of Electronic Circuits-Vols. 1-3* (5857863), billing me just $4.95, plus shipping/handling & tax. Enroll me as a member of the **Electronics Engineers' Book Club** according to the terms outlined in this ad. If not satisfied, I may return the books without obligation and have my membership cancelled.

Name _____

Signature _____
(Required on all orders)

Address/Apt.# _____

City _____ State _____

Zip _____ Phone _____

Valid for new members only, subject to acceptance by EEBC. Canada must remit in U.S. funds drawn on U.S. banks. Applicants outside the U.S. and Canada will receive special ordering instructions. A shipping/handling charge & sales tax will be added to all orders.

RPIF598

Accredited B.S. Degree in Computers or Electronics
by studying at Home

Grantham College of Engineering
offers 3 distance education programs:

- B.S.E.T. emphasis in Electronics
- B.S.E.T. emphasis in Computers
- B.S. in Computer Science

NEW
-Electronics Workbench Professional 5.0 included in our B.S.E.T curriculums
-Approved by more than 200 Companies, VA and Dantes, (tuition assistance avail.)

For your free catalog of our programs dial
1-800-955-2527
http://www.grantham.edu

GCE

Your first step to help yourself better your future!

DISTANCE EDUCATION AND TRAINING COUNCIL DETC ACCREDITED MEMBER

Grantham College of Engineering
34641 Grantham College Road
Slidell, LA 70460-6815

ANTIQUE RADIO CLASSIFIED
Free Sample!
Antique Radio's Largest Circulation Monthly. Articles, Ads & Classifieds.
6-Month Trial: $19.95. 1-Yr: $38.95 ($55.95-1st Class).
A.R.C., P.O. Box 802-L19, Carlisle, MA 01741
Phone:(508) 371-0512 VISA/MC Fax:(508) 371-7129

Trees Make a World of Difference™
Find out how trees can make a world of difference for you, and your neighborhood. For your free brochure write: Trees For America, The National Arbor Day Foundation, Nebraska City, NE 68410.
The National Arbor Day Foundation

BE A TEACHER. BE A HERO.

Call
1-800-45-TEACH.

Ad Council A Public Service of This Publication

EDITORIAL

T-DAY 1998

The government tells us that the economy is in great shape and unemployment is down. That might be true, but it does not change the fact that to get ahead and stay ahead in your career, you need an advantage over your competition.

Nowhere is that more true than in the electronics-servicing profession. For an electronics technician, the challenge is twofold. First, he or she must deal with the types of ups and downs that are common to any profession, especially in these days when companies ruthlessly look after their bottom line. But second, they must make sure that they do not become obsolete.

The problem is that electronics technology is constantly evolving. What was state-of-the-art last year is mundane and common this year. What was state-of-the-art five or ten years ago is now an antique.

So, then, how does an electronics technician stay current? Even more important, how does a technician demonstrate to his present or potential employer that he or she is both up-to-date and competent?

That's where the Certified Electronics Technician (CET) program comes in. Technicians who have earned the CET designation have demonstrated to their employers and colleagues that they have the knowledge needed to deal with today's technologies, and the skills to do so successfully. They have also demonstrated that they have the dedication and desire needed to succeed in their chosen profession.

To honor those professionals who have earned the CET designation, and to encourage others to join their ranks, the International Society of Certified Electronics Technicians (ISCET) has set aside Tuesday, April 21, 1998 as "T-Day," and the week of April 21 through April 25 as "T-Week". As part of the celebration, ISCET has established a network of Volunteer Examiners to help qualified electronics technicians earn the CET designation. To learn more about that opportunity, the CET program, and ISCET, please turn to the story on page 54 or visit ISCET's home page at www.iscet.org. Both you and your career will be glad you did.

Carl Laron

Carl Laron
Editor

LETTERS

SEND YOUR COMMENTS TO THE EDITORS OF ELECTRONICS NOW MAGAZINE

Capacitance-Substitution Box Error

There is an error in the "Audio Update" column in the February 1998 issue of **Electronics Now**. In the schematic for the capacitance-substitution box, only the first row of capacitors connects to one of the binding posts. The PCB layout is correct, and so is the parts-placement diagram. But if you trace through the schematic, you'll see that from the second row on, the capacitors do not connect to both binding posts when switched.

REN TESCHER
via e-mail

If They Build It, Will They Come?

Your editorial in March 1998 raised serious questions. One might also ask, "If a DTV commercial airs, and no one has sets capable of receiving it, can you bill for it?" The answer is clearly NO, since advertising cost is based upon viewers' share data. No viewers means no billing. Will stations convert, with no initial revenue stream, or turn in their licenses for the free use of spectrum? It seems obvious that both cable and over-the-air channels must subsidize their cost for equipment for DTV transmission with real revenue from NTSC standard advertising. The networks had to install new gear when color TV was introduced, but the pie was divided only three ways back then in the late 1950s. As cable multiplied the number of channels, the pie became decimated, raising the investment/return number to perilous levels. The FCC has enabled the subsidization by allowing a flexible mix of broadcasting, so what's the fuss all about? The new sets will have dual-standard performance, and as aging sets are replaced by new ones, we will eventually all have DTV sets.

For me, a professional in the industry who gets to play with the latest toys long before I can afford them at home, the real question is whether we really need High Definition TV. After living with three different DVD players and Laserdisc players, and having seen many HDTV demonstrations, I have personally concluded that what I have is good enough—for now. I bought far more surround sound equipment in the last year than TVs. The next TV I buy must be priced under $1600, offer just as tall a picture as my $800 32-inch set (forget the screen's diagonal measurement, guys), have DTV input capability, and make watching NTSC-format DVDs, LDs, and VHS tape even better. It's simple, really. Are you marketing guys listening?

MICHAEL NEIDICH
Santa Clara, CA

Web Compliment

I just wanted to take a second to compliment you and your entire staff on one of the best Web-site designs I have ever seen. It was clear, concise, and to the point. While it was rather graphics rich, the pages loaded quickly, and I was able to find exactly what I needed (the address change form).

It's great to see someone using the media effectively and creatively. Keep up the good work.

TIM QUINN
via e-mail

A Resource Omitted

I read the item on handheld data acquisition in Don Lancaster's "Tech Musings" column (**Electronics Now**, January 1998). The world's leader in the industry was conspicuously missing from the list of resources. Symbol Technology is the only company that designs, develops, manufactures, and markets its products. Our revenues exceed $700 million, and we are growing at a rate of 20% per year. Interestingly enough, one of our competitors listed (Intemec in Washington) is also a customer. They purchase our scan engines for their products. Many of those listed who are not competitors are customers. If any of your readers are interested in finding out more about us, they can visit our Web site: www.symbol. com.

MARGARETT M. EISENBERG
Senior Human Resources Representative
Symbol Technologies, Inc.
Holtsville, NY EN

Write To:
Letters,
Electronics Now Magazine,
500 Bi-County Blvd.,
Farmingdale, NY 11735

Due to the volume of mail we receive, not all letters can be answered personally. All letters are subject to editing for clarity and length.

POPTRONIX®
Online Edition
We're on the web
FREE
We are starting up, but you can watch us grow!
Projects for beginners to experts!
New Product information!
Bookstore—discover what's new!
http://www.poptronix.com
WE'RE WITH YOU EVERY DAY 24 HOURS A DAY! DROP IN! WE'D LOVE TO HAVE YOU VISIT!

Q & A

READERS' QUESTIONS, EDITORS' ANSWERS

Electronic Dice

Q *I want to build an electronic set of dice using LEDs in the traditional arrangement. The purpose of using LEDs instead of a numeric display is to teach children how to count and add dots. I want to be able to disable one of the two dice for some games. I want to build this project as a Christmas present for my grandchildren. — C. J. G., Sebring, FL*

A Unfortunately, our backlog, and the fact that this column is written four months before publication, didn't allow us to get to this project in time for Christmas. But perhaps the children could enjoy it during summer vacation.

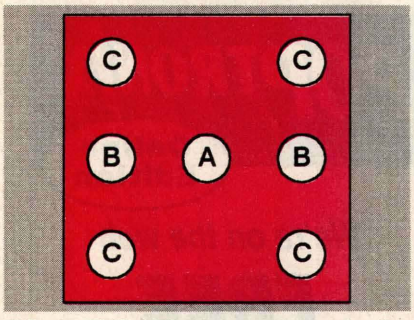


FIG. 1—THE LEDs in our electronic dice are switched in three groups: A, B, and C. Each whole group is either on or off.

As you can see from Fig. 1, the seven LEDs that serve as spots on each die can be switched in three groups, which we'll call A, B, and C. For example, to display 5, you'd turn on groups A and C. Accordingly, the LED drivers, shown in Fig. 2, only need three input signals. Each signal tells whether to illuminate each set of LEDs.

To roll the dice, use the oscillator/counter circuit in Fig. 3. When the button is pressed, the oscillator runs at 5 kHz and the 4017 decade counter activates its outputs, one at a time, too fast for the human user to see, resetting itself whenever the count reaches 7 (output Q6). When the button is released, the oscillator stops, one of the outputs is held high, and the diodes direct the signal to the appropriate combination of A, B, and C outputs, which are connected to the LED drivers.

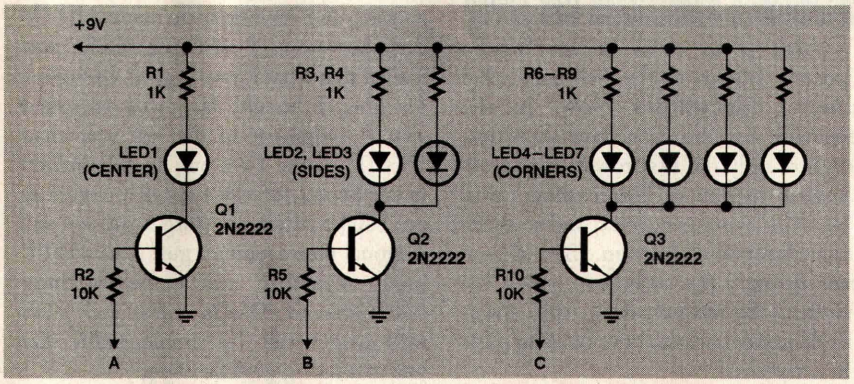


FIG. 2—BECAUSE THE LEDs are driven in three groups, this LED driver circuit needs only three inputs.

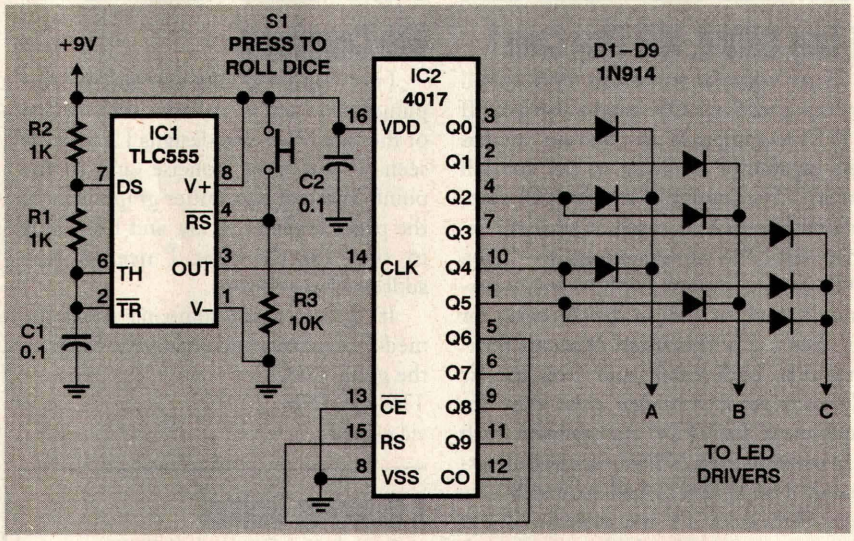


FIG. 3—TO ROLL THE DICE, press switch S1. When the oscillator stops, one of the outputs of the 4017 is left high, determining the dice display.

To build two dice, you can connect one oscillator to two 4017s. To deactivate one die, cut off power to its LED drivers. Leave both 4017s powered up because CMOS chips can be damaged if their inputs are driven while supply voltage is absent.

Weather Satellites

Q *It just occurred to me that the PIC microcontroller chips would be perfect for collecting weather satellite data streams and converting the tone bursts into binary code. Unfortunately, I haven't been able to locate a source for what data streams are transmitted. — N., Waco, TX*

A A more powerful microprocessor might be even better for this—in fact, most satellite experimenters use their

PCs for ease of programming. To learn more about weather satellites, and to see some applicable 8088 assembly code, see the *Weather Satellite Handbook* published by the American Radio Relay League (Newington, CT 06111; Web: www.arrl.org).

Hacking VCR Timers

Q *The electronic timers built into VCRs are handy since they cover long periods (up to a year) and provide for multiple on-off cycles. I have acquired several defunct VCRs and am reusing their timers for other purposes. I've had no trouble finding a switched 12-volt circuit in the VCR and connecting a relay there. To get the timer to work, I had to short out the "cassette-in" switch and cover the end-of-tape detector with black electrical tape. But how can I keep the take-up reel's motion sensor from shutting down the VCR after a few seconds? — E. R. B., Jamaica, NY*

A Reusing VCR timers is a worthwhile idea. However, as you've discovered, VCRs include many protective mechanisms to keep them from eating tapes, and you have to do several things to fool the timer into thinking it's controlling a properly working VCR.

The take-up reel motion detector normally uses an LED whose light is reflected into a photocell by a disk with alternating black and white sectors, creating a pulsing signal. When the pulses stop, the control circuit infers that the tape must not be moving.

You might drive the LED from a flasher circuit (or substitute a flashing LED) and use a stationary white reflector. Or you might feed a low-frequency squarewave (from a 555 or the like) directly into the control chip in place of the signal from the photocell. If you take the latter approach, not knowing the electrical requirements, you should probably start by feeding the signal through a large resistance (such as 1 megohm) and decrease the resistance until you get a response.

Color Subcarrier Frequency

Q *I have an NTSC laserdisc player that I would like to use with my JVC television, which supports PAL, SECAM, and NTSC-4.43 formats. Unfortunately the laserdisc player uses the American standard 3.58-MHz subcarrier frequency, rather than 4.43 MHz, and I can only see the picture in black and white. Is there any circuit I can build to convert the 3.58-MHz signal to 4.43 MHz so I can get color? — N. P., Samambula, Suva, Fiji*

A It doesn't sound simple because what needs converting is a small part of a very complex signal, and it's not a fixed 3.58-MHz oscillation—it's a subcarrier with color information phase-modulated onto it. The conversion circuit would have to demodulate the composite video signal completely into luminance, color, and sound, and modulate it again. This would require much of the circuitry of a television set.

PAL, SECAM, and NTSC are of course the three major systems of color TV modulation (British, French, and American respectively). The NTSC standard specifies a 3.58-MHz subcarrier, but you indicate that your TV uses a 4.43-MHz subcarrier, which is standard for PAL and SECAM. The bottom line is that your TV supports NTSC video only partially.

DESIGNERS
HOBBYISTS
STUDENTS
90% Off!
PROFESSIONAL ELECTRONIC DESIGN SOFTWARE
EDWin NC for Non Commercial Use. Now You Can Benefit from 10 years development for industry in Europe.
EDWin NC Basic* offers a 100 component database with Schematics, PCB Layout, 500 Device Library, Basic Autorouter & PostProcessing on CD Rom (Commercial Use Price $590.00) $59.00*
DELUXE 1 Basic PLUS Professional Libraries and Unlimited Database $99.00*
DELUXE 2 Basic PLUS Profess Libraries and Mixed Mode Simulation $99.00*
DELUXE 3 all the above PLUS Arizona Autorouter ONLY $149.00*
DELUXE 4 ADDS Thermal Analysis, ED SPICE Simulation and ED Co MX (SPICE Model development) ONLY $280.00*
ADEPTEX INC.
Call 1-888-EDWinNC TOLL FREE
(339-4662)
Features Include:
PCB Layout, Schematic Capture Autorouting, Full SMD support, PostProcessing Simulation Integrated Layout Database Comprehenive Start up Libraries, Easily Produced Customized Libraries, Full Pan/Zoom Redraw, Bill of Materials, Design Rule Checking from 1 to 32 Layer Boards, GERBER and NC Drill Outputs, Full Printer/Pen Plotting Help and Manuals on CD-ROM
Major Credit Cards Accepted
Fax: 1-561-393-2945 • E-mail: Edwinnc@aol.com
*add $9.00 S&H plus tax

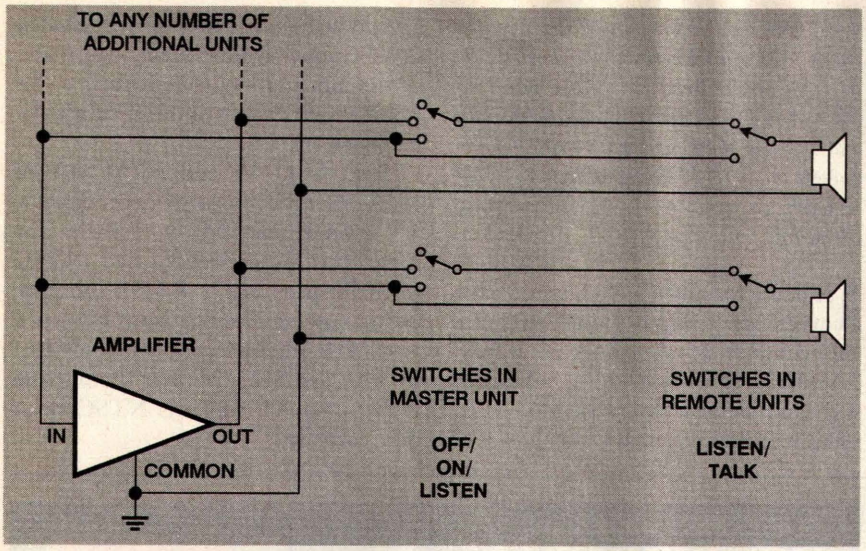


FIG. 4—HOW TO WIRE AN INTERCOM. The master can set any remote unit to off (silence), on (to feed it audio from whomever is talking), or listen (to listen continuously to the remote).

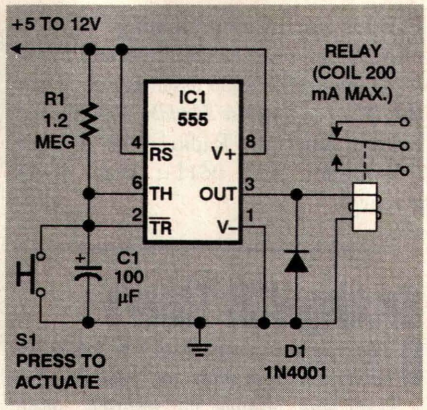


FIG. 5—WHEN THE PUSHBUTTON SWITCH (S1) is closed, the relay closes for two minutes, then opens. Do not use the CMOS versions of the 555 chip (7555, TLC555, etc.) for IC1.

Intercom Wiring

Q *My question is about the intercom you describe in the February 1997 issue (pg. 14). It works very well with two stations, but how can I hook up more than that? — D. R., St.-Augustin-de-Desmaures, Quebec, Canada*

A Note that in the original diagram, the two remote units are connected in parallel. That is, each unit is connected to the same three places in the amplifier circuit. You can connect many more units in parallel with them in the same way.

Figure 4 shows a more sophisticated way to wire an intercom so that the master unit can turn any of the remote units on or off, or place it in continuous "listen" mode (for baby monitoring and the like). When any unit talks, it is heard on all the units that are switched on, not just the master.

The speaker in the master unit is wired just like a remote unit except that it does not need an "on/off/listen" switch; wire it to be "on" all the time.

Two Minutes of Power

Q *I need a 555 timer circuit that will activate a relay for two minutes when a pushbutton is pressed, which means the output will stay high for two minutes, then go low and stay low, and go high for two minutes again when the button is pressed again. The circuit may be similar to "Delayed Power-On" published in November, 1997, pg. 8, but I tried to change it without any luck. — C. L., Pittsburg, KS*

A The circuit is indeed very similar, as shown in Fig. 5. (See also "Five Minutes of Power," which we discussed on pg. 12 in the January 1997 installment of this column.)

The main difference is that the resistor and capacitor are swapped, so that the 555 output goes high when the capacitor is discharged rather than when it is charged. Pressing the button discharges the capacitor, and it takes about two minutes to charge up again.

To drive a relay, be sure to use a conventional bipolar 555 (NE555, LM555), not the CMOS 7555, LMC555, or TLC555—they can't source enough current. Even so, the relay coil must not draw more than 200 mA. Diode D1 protects the 555 from inductive kickback.

The Third Wire

Q *Why does my laptop computer battery pack have three wires instead of two? — R. A. B., Falmouth, VA*

A The third wire probably goes to a temperature sensor that is used to control fast charging.

Point of Grammar

Q *Why do you further the misuse of the English language by speaking of "an LED" ("Q&A," August 1997, page 8, Fig. 2)? — D. W. E., Nappannee, IN*

A It's not an error. The usage of *a* and *an* depends on pronunciation, not spelling. We pronounce LED as "ell ee dee," which begins with a vowel sound, so we put *an* in front of it. If you pronounced it "led," you would of course say "a LED."

Conductive Rubber For LCD

Q *According to your statement at the end of the Q&A page, you welcome questions. I am sorry to say that through all the years I have subscribed to your magazine, I have never received an answer to any of my questions. I hope that you will answer the following:*

In your August 1997 issue, pg. 8, you described the conductive rubber that is used under LCD displays. I have a Precision Data multimeter that uses this material. Apparently, my conductive strips have aged and are not conducting properly. Do you know where I can purchase these strips and how they are identified? — W. B. H., Knoxville, TN

A We regret that we can answer only about a third of the questions we receive. Space limitations are the biggest reason; also, we choose questions that are of wide interest and that we can answer reliably. (Even we don't know everything!)

Sometimes, when a question is a real puzzler, we throw it open for readers to answer. That's what we're going to do with yours, since we've never seen the

HOW TO GET INFORMATION ABOUT ELECTRONICS

On the Internet: See our Web site at http://www.gernsback.com for information and files relating to our magazines (**Electronics Now** and **Popular Electronics**) and links to other useful sites.

To discuss electronics with your fellow enthusiasts, visit the newsgroups sci.electronics.repair, sci.electronics.components, sci.electronics.design, and rec.radio.amateur.homebrew. "For sale" messages are permitted only in rec.radio.swap and misc.industry.electronics.marketplace.

Many electronic component manufacturers have Web pages; see the directory at http://www.hitex.com/chipdir/, or try addresses such as http://www.ti.com and http://www.motorola.com (substituting any company's name or abbreviation as appropriate). Many IC data sheets can be viewed online. Extensive information about how to repair consumer electronic devices and computers can be found at www.repairfaq.org.

Books: Several good introductory electronics books are available at RadioShack, including one on building power supplies.

An excellent general electronics textbook is *The Art of Electronics*, by Paul Horowitz and Winfield Hill, available from the publisher (Cambridge University Press, 1-800-872-7423) or on special order through any bookstore. Its 1125 pages are full of information on how to build working circuits, with a minimum of mathematics.

Also indispensable is *The ARRL Handbook for Radio Amateurs*, comprising 1000 pages of theory, radio circuits, and ready-to-build projects, available from the American Radio Relay League, Newington, CT 06111, and from ham-radio equipment dealers.

Copies of past articles: Copies of past articles in **Electronics Now** and **Popular Electronics** (post 1993 only) are available from our Claggk, Inc., Reprint Department, P.O Box 4099, Farmingdale, NY 11735; Tel: 516-293-3751.

Electronics Now and many other magazines are indexed in the *Reader's Guide to Periodical Literature*, available at your public library. Copies of articles in other magazines can be obtained through your public library's interlibrary loan service; expect to pay about 30 cents a page.

Service manuals: Manuals for radios, TVs, VCRs, audio equipment, and some computers are available from Howard W. Sams & Co., Indianapolis, IN 46214 (1-800-428-7267). The free Sams catalog also lists addresses of manufacturers and parts dealers. Even if an item isn't listed in the catalog, it pays to call Sams; they may have a schematic on file which they can copy for you.

Manuals for older test equipment and ham radio gear are available from Hi Manuals, PO Box 802, Council Bluffs, IA 51502, and Manuals Plus, PO Box 549 Tooele, UT 84074.

Replacement semiconductors: Replacement transistors, ICs, and other semiconductors, marketed by Philips ECG, NTE, and Thomson (SK), are available through most parts dealers (including RadioShack on special order). The ECG, NTE, and SK lines contain a few hundred parts that substitute for many thousands of others; a directory (supplied as a large book and on diskette) tells you which one to use. NTE numbers usually match ECG; SK numbers are different.

Remember that the "2S" in a Japanese type number is usually omitted; a transistor marked D945 is actually a 2SD945.

Hamfests (swap meets) and local organizations: These can be located by writing to the American Radio Relay League (Newington, CT 06111; http://www.arrl.org). A hamfest is an excellent place to pick up used test equipment, older parts, and other items at bargain prices, as well as to meet your fellow electronics enthusiasts—both amateur and professional.

special rubber material for sale as a separate item either. (As explained in November, it's not just a hunk of conductive rubber or plastic; it consists of conductive strata separated by insulators to prevent cross-connections.) Our first suggestion would be that you might ask Precision Data whether they can supply it as a replacement part; after all, their LCD display is probably custom-made. Alternatively, can a reader help?

Pinball Wizard Found

In your September 1997 issue, you had someone wanting old Gottlieb parts. Most parts for pinball machines can usually be obtained at local distributors, but Gottlieb is out of business. The only place I know of so far that has parts for their machines is Two Bit Score, 4418 Pack Saddle Pass, Austin, TX 78745, Tel: 512-447-8888. — Staci Steddum, Wichita, KS

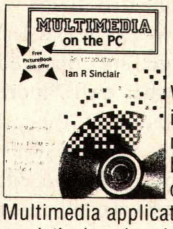
Writing to Q&A

That's all for this month. As always, we welcome your questions; please write to: "Q&A," **Electronics Now** Magazine, 500 Bi-County Blvd., Farmingdale, NY 11735. The most interesting ones are answered in print. Please be sure to include plenty of background information (we'll shorten your letter for publication). *If you are asking about a circuit, please include a complete diagram.* Due to the volume of mail, we regret that we cannot give personal replies. **EN**

WINDOWS 95
—One Step at a Time

Don't know what to do when confronted with Microsoft's Windows 95 screen? Then you need a copy of ***Windows 95–One Step at a Time.*** Develop your expertise with the straight-forward presentation of the frequently-used features that make Windows 95 so valuable to the PC user.

To order Book BP399 send $8.99 plus $3.00 for shipping in the U.S. and Canada only to **Electronics Technology Today Inc.**, P.O. Box 240, Massapequa Park, NY 11762-0240. Payment in U.S. funds by U.S. bank check or International Money Order. Please allow 6-8 weeks for delivery.



MULTIMEDIA on the PC!

What is Multimedia? What can it do for you? It can do lots of nice things! This 184-page book helps you create your own multimedia presentation. Multimedia applications by people like you can revolutionize educational and business applications as well as bring more FUN, FUN, FUN into your leisure computer activities.

Mail coupon to:

Electronics Technology Today, Inc.
P.O. Box 240
Massapequa Park, NY 11762-0240

Please send me my copy of *Multimedia on the PC* (PCP120). I enclose a check or money order for **$18.95** to cover the book's cost and shipping-and-handling expenses. NY state resident must add local sales tax.

Name _____

Address _____

City _____ State _____ Zip _____

All orders must be paid in U.S. funds only. Sorry, no orders accepted outside of USA and Canada. Please allow 6-8 weeks for delivery. MA02

BY JEFF HOLTZMAN
COMPUTER EDITOR

The platform is the UI

WE'VE BEEN RUBBING OUR NOSES PRETTY DEEPLY IN PALMPILOT PROGRAMMING THE PAST FEW MONTHS. I THINK WE'VE GOTTEN A PRETTY GOOD IDEA OF WHAT'S INVOLVED, INCLUDING THE CAPABILITIES AND LIMITATIONS OF the target platform, the development tools, and the development process. It's time now to back up a little, take stock of where we've been, why we went down that path, and chart a new direction.

I was initially attracted to the PalmPilot for some pretty mundane reasons—basically, I thought it would help me solve some pretty mundane problems, such as appointment tracking, time and billing, and the other things that an organizer should do. After purchasing my Pilot, I quickly realized that there was more to it than just a better (or at least more modern) way of getting organized.

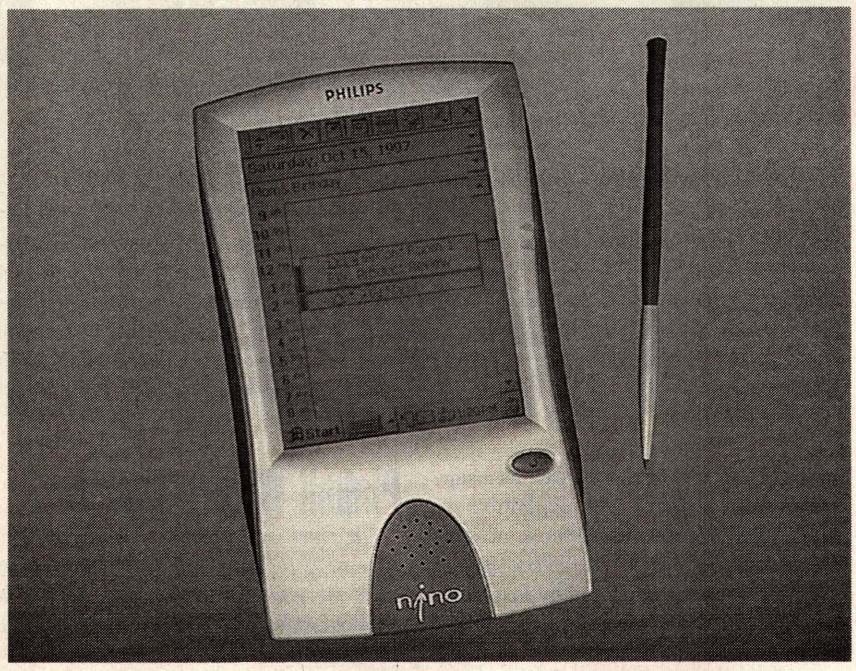
My view of just what that "more" amounts to has evolved over the past year, but in essence in comes down to this: Probably unintentionally, the Pilot has become the first serious challenge to the Wintel platform since perhaps the introduction of the Macintosh. No, I'm not suggesting that the Palm OS will soon or ever overtake Windows, or that the Dragonball 68K CPU is going to put Intel out of business.

What Palm has done is create a new *platform*. In the computer business, the term *platform* usually denotes a CPU family, a hardware architecture, and an operating system. For our purposes, I want to use the term somewhat differently. Here it means an intellectual, business, and even cultural magnet, with increasing momentum, like a snowball rolling downhill.

This new *platform* is making Palm (3Com) a little more successful as a company. It is also spawning a slew of other companies building products to complement the platform. Those products span a broad range, including system hacks, utility programs, application programs, accessories such as styli and cases, peripherals such as keyboards and IRDA connectivity (soon), and even complete OS replacements for special markets and other languages. Most importantly in our hype-ridden age (witness Java), it shows that another platform can be a viable business proposition.

That has all happened in a very short period of time—less than two years. There is excitement among both users and developers unlike anything I've seen for a long time. To many of us, the whole phenomenon is strongly reminiscent of the early and mid eighties, when the PC *platform* was starting to take off.

The surest sign that what I'm saying is true is the way Microsoft is scrambling to produce a workable version of Windows CE, and the way the hardware manufacturers such as Compaq, HP, TI, Casio, and Philips are scrambling to evolve their designs to track that of the Pilot. As I write this, CES is just a few



THE NINO 300 FROM PHILIPS is one of the first of a new generation of palm computers that use the Windows CE 2.0 operating system. It is designed to compete directly with the PalmPilot.

days away. At that show, Microsoft's Gryphon (read: Pilot wannabe) *platform* will be released. It is going to be very interesting to see what happens this year as the first Gryphon machines are released, coincident with the third generation of Palm devices.

The UI is the Problem

Now zoom out. In the overall landscape, there is probably a 200:1 ratio between Wintel machines and PalmPilots. Further, they don't even compete, right? So why is Microsoft so worried? Perhaps because the race is not yet over.

The race? What race? The race to mature-industry status, like automobiles, washing machines, refrigerators, even telephones.

With the advent of pretty darn capable $1000 machines the past year or so, it could be argued that PCs have reached commodity status; that is, that they are distinguished more by price and marketing than by technology and innovation.

The problem is the user interface. And (as always) I don't simply mean the arrangement of GUI elements on a screen. I'm talking about the whole *gestalt* of the computer experience. Some of it is technology driven; some, socially driven. To begin with the latter, there has to be a certain level of invisible social awareness and comprehension of a technology for it to become truly ubiquitous, like the automobile.

Nearly every normal person in our society knows what an automobile is, what is its purpose, and how to use it. Usage training is an integrated part of growing up. Not so with computers, not by a long-shot. And why not? Because they are too hard to use.

I don't mean that word processors or windowing systems themselves are too hard to use. I mean that the whole experience of computing is too hard for most people. This means system-level stuff like fragile configuration management, system and data vulnerability, maintenance, and upgrades.

Think about it. How many (nontechnical) users do you know who don't do backups? Has your machine ever been trashed by a corrupt registry? How do you handle system and application software upgrades? Hardware upgrades? System transfers?

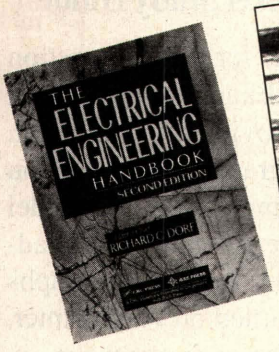
What we need are "unbreakable" systems. (Spare me; I'm well aware nothing is truly unbreakable.) At a minimum, systems that you would have to consciously rather than inadvertently or ignorantly break.

Perhaps some examples will make things clearer. Suppose we had a system that:

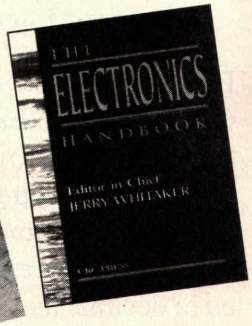
- Password-protects all system-level resources so that you couldn't accidentally format your C drive, or erase all the DLLs in your system directory;
- Allows additional storage to be "mounted" under a unified filing system (like UNIX);
- Predicts and provides notification of incipient hardware failure;
- Predicts and provides notification of incipient resource depletion (*e.g.*, out of hard drive space, disk thrashing due to insufficient RAM);
- Provides a clean, simple method of moving a (software) system from one (hardware) host to another;
- Provides automatic and invisible backup through some RAID-like technology;
- Provides a built-in uninterruptible power supply;
- Provides a fool-proof way of per-

(Continued on page 26)

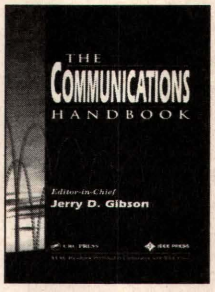
New and Bestselling Titles *from* CRC PRESS



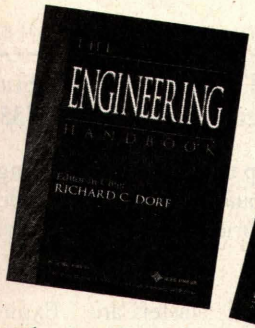
Electrical Engineering Handbook
Catalog no. 8574
January 1998, 2,752 pp.
ISBN: 0-8493-8574-1
$115.00



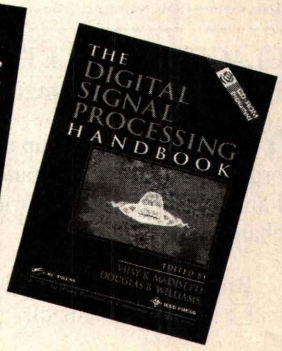
Electronics Handbook
Catalog no. 8345
1997, 2,624 pp.
ISBN: 0-8493-8345-5
$115.00



Communications Handbook
Catalog no. 8349
1997, 1,632 pp.
ISBN: 0-8493-8349-8
$135.00



The Engineering Handbook
Catalog no. 8344
1996, 2,352 pp.
ISBN: 0-8493-8344-7
$115.00



Digital Signal Processing Handbook
Catalog no. 8572
Janaury 1998, 1,776 pp.
ISBN: 0-8493-8572-5
$129.95

Mention 'Electronics Now'
and recieve 10% off book list price!

visit us at our
web site!
http://www.crcpress.com

For more information, please call 1-800-272-7737 or write to:
CRC PRESS • 2000 Corporate Blvd., N.W. • Boca Raton, FL 33431
In Florida and outside the U.S., please call 561-994-0555
Order Code: NOW01

Contact us through e-mail:
orders@crcpress.com

The Electronics Industry is looking for a lot of good people!

Here is your chance to get in on the ground floor as an Associate CET. Is your job title "Electronics Service Technician?" Would you like to have that title? You can prove you qualify for the title with a CET Associate Certificate. It can be your career door-opener and begin your rapid advancement!

A technician or student of electronics with less than a total of four years of basic experience may take the Associate Level Exam. The exam is the basic electronics portion of the full-credit CET exam. The 75-question, multiple-choice test covers basic electronics, math, DC and AC circuits, transistors and semiconductors, instruments, measurements and troubleshooting. A successful Associate CET will receive a wall certificate valid for four years and is eligible to join ISCET as an Associate Member. ISCET is the International Society of Certified Electronics Technicians.

The ISCET Computer-Aided Associate-Level Study Guide prepares you for the Associate CET Certificate by randomly selecting sample questions with appropriate diagrams, provides multiple-choice answers, grades the test and provides a summary of your strong and weak points.

Diskette requires IBM computer or compatible with VGA color monitor, 3.5-in. drive and a hard-disk drive.

CLAGGK INC. – CET Computer-Aided Study Guide Offer
PO Box 4099, Farmingdale, New York 11735

YES, I want to step up to a career in servicing. Here is my order for the CET Computer-Aided Study Guide on a 3.5 diskette. I am enclosing **$39.95** (price includes shipping and handling changes) in U.S. funds.

Bill my ☐ VISA ☐ MasterCard Expire Date __/__/__
☐ USA Bank Check ☐ US or International Money Order

Card No. _____

Signature _____

Name (Please Print)_____

Address _____

City _____ State _____ Zip _____

New York residents add local sales taxes. Canadians add $6.00 per order. No foreign orders. Do not send cash. Checks drawn on US Bank and International Money Orders in US funds only. Credit card users may telephone or FAX orders. Telephone 516-293-3751 or FAX 516-293-3115. Price subject to change. Allow 6 to 8 weeks for delivery.

CB06

Proof Positive that you are a Certified Electronics Technician

A New Computer Software Program — ISCET Computer-Aided Associate-Level Study Guide

Prepare yourself for the 75-question CET Associate Examination. Model examinations provide the technician with a study program and introduction to the actual examinations. The model examinations are automatically graded in decimal numbers and bar graphs that can be outputted on your printer. The questions for each exam are selected randomly from a loaded data base—no two exams are exactly the same. When you answer a question, the correct answer is displayed and an explanation is given. From the printouts you will determine whether you need more practice and in which topic areas, or if you are ready to take the real test and continue to promote your electronics career today!

Prototype

On The Floor at CES

If you've never attended a mega trade show like the Winter Consumer Electronics Show, the experience is hard to describe adequately. Part serious business forum, part crazed carnival on steroids, it could only be held in Las Vegas—a city where it is very hard to tell reality from fantasy.

Usually, the show produces lots of heat and smoke, but little fire. Occasionally, however, a trend or product that will profoundly affect some part of our lives will make its first appearance on the show floor. Thanks in part to the FCC's ruling on DTV (digital TV), this was one of those rare years.

Be Digital or Be Square

Despite the fact that no one, including broadcasters and manufacturers, is really quite sure what shape digital TV will take, and despite the fact that DVD sales, while "acceptable" for a first year product, fell quite a bit short of the hype that accompanied its introduction, it seemed that every manufacturer found some way to work the word "digital" into their product offerings. But without a doubt, the 800-pound gorilla of the show was DTV. Every manufacturer of television sets, video displays, or any type of video product, had to deal with the coming change in standards in some way.

Of course, the ones most directly impacted were the set manufacturers. Without exception, every company from the major players to the smallest supplier of off-brand sets from the Pacific Rim showed some type of DTV, and most showed wide-screen models. Most manufacturers expect that initial buyers will be the so-called "early adopters" who generally have excess funds at their disposal and want to be the first on the block with the latest technological advances. As such, most of the initial DTV products will be high-end, high-cost, large-screen 16:9 models capable of producing a full 1080-line (interlaced) HDTV image.

But what about the rest of us? The full switch to DTV is not scheduled until 2006 at the earliest. However, most feel that even that target date is unattainable. Because of that, manufacturers are bringing a new generation of "DTV-ready" analog sets to market. Those sets look and work just like the TVs we are all accustomed to, but include component-video and/or RGB inputs. Typically, manufacturers will be adding these features to their higher-end, large-screen models first. A few models are already available—in fact, high-end video projectors with RGB inputs have been available for many years—with many more slated to be available by this fall.

Of course, if a DTV-ready set is to receive a DTV broadcast, some type of set-top decoder box will be needed. Again, almost everyone had black-box prototypes, but most manufacturers were vague about costs and delivery dates. One exception was Zenith, which announced that they would have a full-featured decoder available this spring. The cost? It carries a suggested list price of $5995.

Of course, not all the digital news was DTV. Almost all manufacturers announced new DVD offerings. Among other things, this coming year will see DVD changers and portable DVD players. Several manufacturers announced DIVX players, though others were vague about plans to support the controversial DVD-derivative format. For more on DIVX, see the Editorial in the December 1997 issue of **Electronics Now.**

MOST OF THE FIRST DTV PRODUCTS are slated to be wide-screen, high-end models like this 64-inch rear-projection model from Philips.

FOR MORE INFORMATION

Crosley Radio
1220 E. Oak Street
Louisville, KY 40204
Tel: 502-583-4246
Fax: 502-584-8531

emWare, Inc.
1225 E. Fort Union Blvd.
Suite 200
Midvale, UT 84047
Tel: 801-256-3883
Fax: 801-256-9267
E-mail: sales@emware.com
Web: www.emware.com

ESP Electronics
11666 Gateway Blvd
Suite 205
Los Angeles, CA 90064
Tel: 310-473-2874
Fax: 310-391-0058

Intel Corp.
200 Mission College Blvd.
Santa Clara, CA 95052-8119
Tel: 408-765-1702
Fax: 408-765-1568

Microsoft Corp.
1 Microsoft Way
Redmond, WA 98052
Tel: 425-882-8080
Fax: 425-936-7329
Web: www.microsoft.com

NUWAVE Technologies, Inc.
One Passaic Ave.
Fairfield, NJ 07004
Tel: 201-882-8810
Fax: 201-882-8812
Web: www.nuwav.com

Panasonic Consumer Electronics Company
One Panasonic Way
Secaucus, NJ 07094-2999
Tel: 201-348-7000
Fax: 201-348-7209
Web: www.panasonic.com/pcec

Philips
4 Perimeter Center East
Atlanta, GA 30346-6401
Tel: 770-821-2400
Fax: 770-821-3126
E-mail: info@philipsmagnavox.com
Web: www.philipsmagnavox.com

Sharp
Sharp Plaza
Mahwah, NJ 07430
Tel: 201-529-8200
Fax: 201-529-8919
Web: www.sharp-usa.com

Thomson Consumer Electronics
10330 North Meridian Street
INH-310
Indianapolis, IN 46290
Tel: 317-587-3000
Fax: 317-587-6731
Web: www.rca-electronics.com

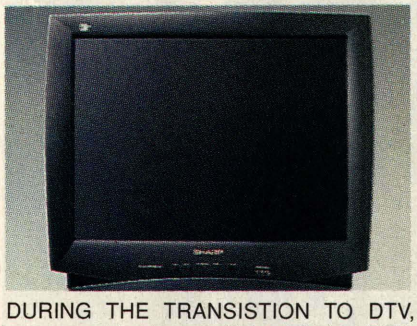
Tri-Vision Electronics
41 Pullman Court
Scarborough, ONT
Canada M1X 1E4
Tel: 416-298-8551
Fax: 416-298-7976
E-mail: tvision@istar.ca

Zenith
1000 Milwaukee Avenue
Glenview, IL 60025
Tel: 847-391-7000
Fax: 847-391-5273
Web: www.zenith.com

The Shape of TV

We already know that, thanks to DTV, one of the future shapes of television will be wide. However, to that you might also be able to add flat and round.

A flat TV that consumers could hang on a wall just like a picture has been a holy grail for the consumer-electronics industry for decades. Now, that grail is finally within reach. Nearly every TV manufacturer had a large-screen, 16:9 format, flat-panel set on display. Nearly all were based on plasma technology (Sharp showed one that was a plasma/LCD hybrid), nearly all were prototypes (though a few are scheduled to ship this year and one should be available by the time you read this), and all were very expensive ($11,000 and up). Typically, the sets on display were no more than about 4-inches thick and sported screen sizes of 42 inches (diagonal). For more on the technology behind these sets, see "Get the Big Picture" elsewhere in this installment of "Prototype."



DURING THE TRANSISTION TO DTV, most manufacturers will be offering DTV-ready analog sets like this 36-inch model from Sharp.

OK; we've taken care of wide and flat, but round? Believe it or not, one small company, ESP Electronics, was demonstrating a "360-Degree Television" that produces a 19-inch picture and offers in-the-round theater-style viewing to watchers seated on all sides of the unit.

There were a couple of drawbacks, however. One was cost; the unit is slated to be limited to a collectors-edition run of 1000 sets, each with a price of $40,000. The other was that the unit on display suffered from extreme flicker. Talking to company officials, we learned that they had solved the problem, but did not have enough time to implement that solution prior to the show.

Other News

A show as large and diverse as CES is difficult to fully summarize in the space we have available, but there were a few other noteworthy trends and developments.

Home security and the Internet would seem like topics that are far removed from each other, yet products and systems that used the Internet in home-security and remote-control applications were shown by several companies, including Intel. One company, emWare, demonstrated a prototype Weiser "Powerbolt" door lock that can be controlled over the Internet using their software.

The much ballyhooed V-Chip also made its debut at CES. The Telecommunications Act of 1996 required the V-Chip to be incorporated into new TV designs beginning this

TO RECEIVE DIGITAL SIGNALS ON AN ANALOG SET, a viewer will need a set-top box. One of the first on the market is this unit from Zenith.

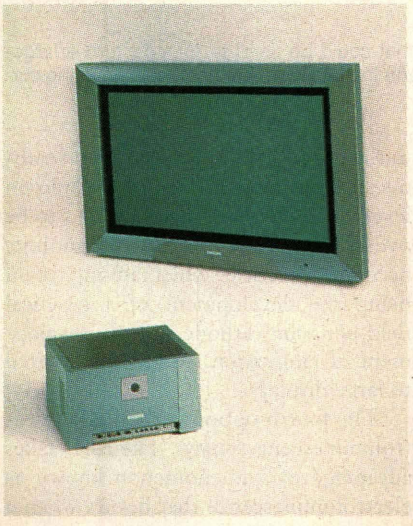
year. For those who want to exercise parental control without buying a new set, Tri-Vision had on display four outboard units that work with existing sets and the current TV-rating system to electronically control youngsters' access to TV programming. The inventor of the V-Chip, Tim Collings, is on Tri-Vision's board of directors.

PANASONIC WILL BE OFFERING a portable DVD player later on this year.

PRESIDENT CLINTON is seen here holding a prototype V-Chip board. Tri-Vision will be offering add-on V-Chip units designed to work with existing sets.

Another product that generated some attention was Philips new audio CD recorder. Though technically not a new introduction—it has been available at a few select retailers since the fall—it will be distributed to mainstream electronics retailers during the coming year. The recorder allows home users to make their own CDs, which will have all the features and quality of professionally produced discs. To prevent unregulated disc duplication, the player supports the various international copy-protection agreements.

In the midst of all of this future technology, there were also a few islands of nostalgia. A couple of companies exhibited specialty radios with a distinctly antique look. One even sported an antique name—Crosley Radio.



USING PLASMA-DISPLAY TECHNOLOGY,large screen flatTVs like this unit from Philips have finally become a reality.

A few noteworthy technologies were also on exhibit off the main floor. One company, NUWAVE, was demonstrating its video-processing technology in a suite at the Riviera Hotel. That technology, already available in a stand-alone processor aimed at the professional market, improves image clarity, color, contrast, and brightness. Particularly striking was the fact that the processor can increase an image's apparent dynamic range—deeper black levels can be set without affecting the white levels of the image. From a viewer's point of view, that means that details can be brought out of shadows or dark areas without adversely affecting the rest of the image. Among the plans discussed were a possible mass-market consumer product and the availability of the technology on an ASIC IC for OEMs. Shortly after the show's end, NUWAVE announced that they had signed an agreement with Thomson (manufacturers of RCA, GE, and ProScan sets) to include their video-processing ASIC in that company's future products.

On the computer side, Microsoft had a major presence at this year's show as it launched its Windows CE 2.0 operating system. One application for the new OS is in Palm computers, and several manufacturers announced units that made use of it. For more on that, see "Computer Connections" elsewhere in this issue of **Electronics Now.**

WHEN MICROSOFT TALKS about its "Windows Everywhere" philosophy, they mean what they say as evidenced by this Auto PC that runs on the new Windows CE 2.0 operating system.

However, Palm computers are not the only application for CE 2.0. There is perhaps no better demonstration that Microsoft meant what it said with its "Windows Everywhere" philosophy than the Auto PC.

The Auto PC is an in-dash automo-

tive computing system. Built around the CE 2.0 platform, Auto PC adds speech-recognition technology, a visual interface, and other car-oriented features to create "an information and entertainment device" for the automobile. An Auto PC unit can be used to send and receive e-mail, dial a cell phone, locate and/or navigate to a location, obtain weather and traffic information, and control the car's entertainment system (radio, CD, etc.). Through the use of speech recognition, all of that could be accomplished without the driver taking his hands off the wheel or his eyes off the road. PT

Get The Big Picture

Since at least the 1950s, researchers have said that a practical large-screen, flat, wall-hanging TV display was about ten years away. Well, after nearly a half-century, those ten years have finally passed. At the just concluded CES, nearly every manufacturer of TVs showed some type of large-screen (typically 42-inches diagonal measure, 16:9 aspect ratio) flat-panel TV. While some remain prototypes, several manufacturers plan to ship units this year, with at least one scheduled to be on the market by the time you read this. For more information on those, see "On the Floor at CES" elsewhere in this installment of "Prototype." In this article, we will be looking at the technology that has made those flat TVs finally a reality.

Flat Panel Technology

There are four technologies that can be used to create a large, flat display. Those are summarized in Fig. 1.

The first is the LCD (liquid crystal display). LCDs have the ability to change the light transmission coefficient of a liquid crystal. Generally, small fluorescent lamps are placed behind the screen to serve as a backlight. The strength of the light transmitted from the backlight is modulated to display text, graphics, and other information. Today LCDs are mass produced in sizes of several inches to well over ten inches for use in small television sets, word processors, and personal computer terminals. TFT-LCDs have TFTs (thin film transistors) on every picture element (pixel) for excellent image reproduction. The drawback to this technology is that the displays are complex devices, and making them requires every bit as much precision as manufacturing integrated circuits. Because of that, it is currently impractical, both in terms of technology and production investments, to manufacture anything much larger than a 40-inch LCD panel.

FUJITSU'S PLASMAVISION 42EP is a second-generation, DC, PDP flat-panel display that is now commercially available. It carries a suggested price of $10,999.

The second option is the PDP (plasma display panel). In a PDP, a panel of microscopic plasma-discharge cells are closely arrayed along vertical and horizontal axes. PDPs work under the same principle as fluorescent lamps. Information is displayed by adjusting the duration of the discharge by controlling the electrodes of every single cell. An electrical discharge generates ultraviolet waves that excite phosphors. Perhaps PDPs are best imagined as a huge number of tiny fluorescent lamps squeezed between two sheets of glass. PDPs have the advantage of simplicity of structure, which makes them a practical choice even for screens of more than 40 inches, and because they are based on the light emitted by phosphors, they are easy to colorize to achieve natural-looking color reproduction.

The third choice is the FED (field-emission display). FEDs have a large number of field-emission cathodes arrayed on a plane. Those cathodes emit electron beams that excite phosphors. The technology was made possible by advances in semiconductor technology to the point that the field-emission cathodes can be miniaturized to the micron level. Still, there are many hurdles to be overcome before the technology becomes practical, chief among them being the development of a practical field-emission cathode and the development of fabrication technologies suited to large displays.

The fourth option is the ELD (electroluminescent display). The ELD takes advantage of a phenomenon known as electroluminescence that occurs when a strong electric field is applied to a phosphor. Ten-inch ELDs emitting yellow-orange light are already on the market,

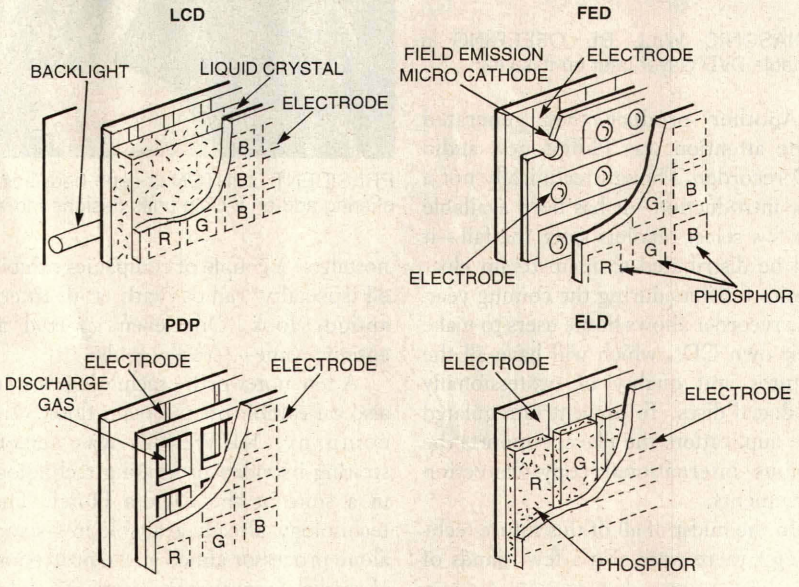


FIG. 1—FOUR POSSIBLE TECHNOLOGIES that could be used to manufacture a large-screen, flat-panel display. Of the four, the PLD and the LCD are the most feasible using current technology.

GET HERE.

New Web Site!
Visit our new web site at
www.cie-wc.edu
• Preview a sample from one of our lessons, detailed course descriptions, visit the bookstore, order a free catalog & much more!

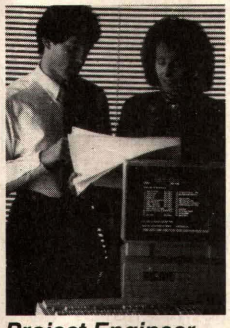
LEARN A SKILL YOU ENJOY...
...THEN FIND A JOB THAT HAS A FUTURE.

Everyone has to start somewhere.

As 150,000 CIE graduates have discovered, independent-study from The Cleveland Institute of Electronics can get you were you want to be. *In a secure, financially rewarding, exciting career field of your choice.*

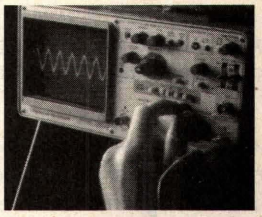
Industrial Robotics

Since 1934, CIE has been on the forefront of an ever expanding technological revolution ment. CIE's curriculum is unique from other independent-study schools in the respect that we not only provide hands-on training utilizing today's technology we also instill the knowledge and understanding of why technology works the way it does. This is the foundation upon which every CIE graduate can trace their success back to and in which CIE's reputation as a quality learning facility is based on.



Project Engineer

Independent study is not for everyone. But, if you have the desire, the basic intellect and the motivation to succeed, CIE can make it happen. Our learning program is patented and each lesson is designed for independent study while our instructors are available to assist you whenever you feel you need help. In fact, CIE's curriculum is so well respected many Fortune 1000 companies utilize it for their own employees.

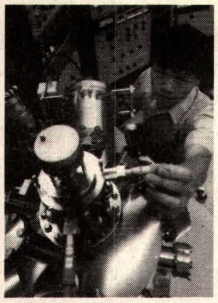


Telecommunications

CIE offers personalized training to match your background with over ten career courses, an Associate Degree Program and a Bachelor Degree Program through our affiliation with World College. And every CIE graduate got started in a successful career the same way you can...by sending for your free CIE course catalog and judging for yourself if CIE's for you.

Computer Programming

START HERE...



Electronics

Back then it was radio and TV, today it's computer technology, programming and the electronics that make it all possible. Today and yesterday's similarities are uncanny... *Employers are looking for qualified applicants to hire and having a hard time finding them.*

Students at CIE receive the training and the education needed to get hired and to succeed in challenging fields such as computer programming, robotics, broadcast engineering, and information systems manage-

YES! Please send me more information on:

- ☐ CIE's Associate Degree Program
- ☐ CIE's Computer Programming Course
- ☐ CIE's 12 Career Courses
- ☐ World College's Bachelor Degree Program

AE120

Name _____

Address _____

City _____

State _____ Zip _____

Phone: _____

Check for G.I. Bill Details
☐ Active Duty ☐ Veteran

CIE

It's More Than Just Training...
...It's an Education.

1776 East 17th Street
Cleveland, OH 44114
(216) 781-9400 • 1-800-243-6446

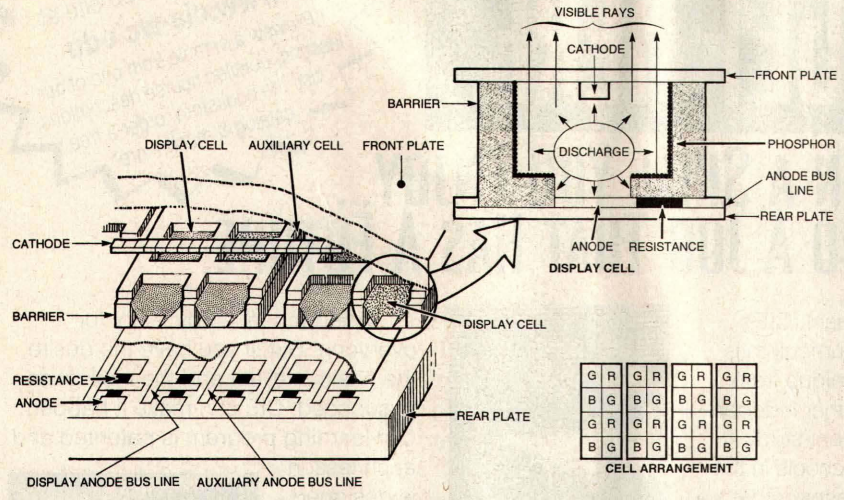


FIG. 2—INSIDE A DC PLD. By adding auxiliary cells and by adding extra green cells, developers have improved image quality to the point where it is suitable for HDTV use.

and there has recently been a surge in research on electroluminescent materials able to give off the three primary colors with high levels of brightness and luminance. Some manufacturers have even created prototypes of small multicolor displays. Application to larger screens will, however, require improvements in brightness and luminance.

Among all of these possible technologies, the ones most practical for large-screen displays using present-day technology are LCDs and PDPs. However, as discussed above, while LCDs are commonly used in small-screen applications, such as in portable computers, there are many technological and cost hurdles in creating a practical large-screen LCD display.

One possible way around those problems might be a hybrid technology called PALC (plasma addressed liquid crystal) that combines the two. In a PALC, an LCD layer is placed on top of a PDP. The "plasma addressing" plays the same role as transistor switching for TFT-LCDs; when the plasma discharges, the same thing occurs as if the transistor switch were shut. That enables the transmission coefficient of the liquid crystal to be changed and therefore the brightness to be regulated.

PALCs require a backlight just as conventional LCDs do. However, they do not require large numbers of transistors formed over a large surface, so they are potentially viable for larger screens. Unfortunately, they also suffer from the LCD's most characteristic problem—the brightness and contrast differs depending upon the viewing angle. Solving that problem will be essential for the technology to catch on. Still, the technology is promising enough for three major manufacturers—Sharp, Sony, and Philips—to join forces to develop a practical set, and Sharp demonstrated a prototype PALC at CES.

That said, the technology most manufacturers are turning to is the PDP, and aside from the Sharp PALC, every large-screen flat-panel display shown at CES was of that type. Let's look a little more closely at the PDP.

Inside the PDP

PDPs come in two varieties, AC and DC. In the AC version, the electrode is covered by the dielectric layer and operated with alternating current. The AC PDP has the advantages of structural simplicity, easy fabrication, and lower production costs, and their screens provide almost as much detail as conventional televisions. But while they are bright enough, they still have problems with contrast and with picture quality when moving images are displayed.

The DC version exposes the electrode to the discharge space and operates under direct current. Let's look at it in more detail (see Fig. 2).

Getting a clear picture out of a PDP requires that all of the display cells discharge in a stable manner. In practical terms that requires that display cells produce other stable discharges in addition to those for the display of information (display discharges). Those are called "auxiliary discharges," and without them the screen looks like a fluorescent lamp when it is first turned on, blinking and flickering erratically. However, because the PDP has stable auxiliary discharges taking place within its display cells, fluorescent light is being generated even during dark scenes, resulting in a lack of contrast. The brightness and darkness of the screen is controlled by changing the discharge duration of individual cells, but when fast movements are displayed, the picture quality rapidly deteriorates—faces take on lines that make them look like the contour lines on maps.

The DC PDP gets around those problems by adding auxiliary cells that do nothing but produce the auxiliary discharges, thereby preventing any declines in contrast. The developers also rethought the entire concept of using discharge duration to control brightness, with a marked improvement in picture quality especially for fast movement. They have tinkered with cell arrangement as well. Display cells are typically arranged with one cell of red, another of green, and another of blue in a horizontal formation. Green, however, plays a large part in screen sharpness, so the developers have put one cell of green after each cell of the other two colors. That arrangement of green cells has improved display resolution to the point where it is suitable for Japan's Hi-Vision (HDTV) broadcasts.

Still, despite the excitement from some display manufacturers, there are serious hurdles that must be overcome if PDPs are to be accepted in the public's living rooms. One huge one is cost. Pricing for the first units is high, running in the low to mid five figures. It is reasonable to expect those costs to go down with time, but for that to happen will require improvements in the panel production processes, an increase in the yield of the panels that can be used, and improvements in the drive circuit (which is costlier because it uses a higher operating voltage than LCDs). One industry spokesman predicted a cost of $100/inch in a few years. That means that a 42-inch PLD display would cost a still-high $4200.—PORTIONS BY NISHIZAWA TAIJI, COURTESY LOOK JAPAN (SEPTEMBER 1997) PT

RETAILERS THAT SELL OUR MAGAZINE MONTHLY

California

California Electronics
221 N. Johnson Ave.
El Cajon, CA 90202

Ford Electronics
8431 Commonwealth Avenue
Buena Park, CA 90621

All Electronics
14928 Oxnard Street
Van Nuys, CA 91411

Gateway Electronics of CA
9222 Chesapeake Drive
San Diego, CA 92123

Mac's Electronics
191 South "E" Street
San Bernardino, CA 92401

Electronics Warehouse
2691 Main Street
Riverside, CA 92501

Orvac Electronics
1645 E Orangethorpe Ave.
Fullerton, CA 92631

Sav-On Electronics
13225 Harbor Blvd.
Garden Grove, CA 92643

JK Electronics
6395 Westminster Blvd.
Westminster, CA 92683

Kandarian Electronics
1101 19th Street
Bakersfield, CA 93301

Whitcomm Electronics
105 W. Dakota #106
Clovif, CA 93612

Minuteman Electronics
37111 Post St., Suite 1
Fremont, CA 94536

HCS Electronics
6819 S. Redwood Drive
Cotati, CA 94931

Halted Specialties Co.
3500 Ryder Street
Santa Clara, CA 95051

Metro Electronics
1831 J Street
Sacramento, CA 95814

HSC Electronics
4837 Amber Lane
Sacramento, CA 95841

Colorado

Gateway Electronics of CO
2525 Federal Blvd.
Denver, CO 80211

Centennial Electronics
2324 E. Bijou
Colorado Sps., CO 80909

Connecticut

Cables & Connectors
2198 Berlin Turnpike
Newington, CT 06111

Electronic Service Prod.
437 Washington Avenue
North Haven, CT 06473

Georgia

Norman's Electronics, Inc.
3653 Clairmont Road
Chamblee, GA 30341

Illinois

Tri State Elex
200 W. Northwest Hwy.
Mt. Prospect, IL 60056

Kansas

Electronic Hobby Shop
309 E. McKay
Frontenac, KS 66763

Maryland

Mark Elec. Supply Inc.
5015 Herzel Place
Beltsville, MD 20705

Amateur Radio Center
1117 West 36th Street
Baltimore, MD 21211

Massachusetts

U-Do-It Electronics
40 Franklin Street
Needham, MA 02194

Michigan

Purchase Radio Supply
327 East Hoover Avenue
Ann Arbor, MI 48104

Norwest Electronics
33760 Plymouth Road
Livonia, MI 48150

The Elec. Connection
37387 Ford Road
Westland, MI 48185

Elec. Parts Specialists
711 Kelso Street
Flint, MI 48506

Minnesota

Acme Electronics
224 Washington Avenue N.
Minneapolis, MN 55401

Missouri

Gateway Electronics Of MO
8123-25 Page Blvd.
St. Louis, MO 63130

New Jersey

Lashen Electronics Inc.
21 Broadway
Denville, NJ 07834

New York

R&E Electronics
4991 Rt. 209
Accord, NY 12404

Unicorn Electronics
Valley Plaza
Johnson City, NY 13790

Ohio

Philcap Electronic Suppliers
275 E. Market Street
Akron, OH 44308

Oregon

Norvac Electronics
7940 SW Nimbus Avenue
Beaverton, OR 97005

Taztronics
257 N. Wasson St.
Coos Bay, OR 97420

Pennsylvania

Business & Computer Bookstore
213 N. Easton Road
Willow Grove, PA 19090

Texas

Mouser Electronics
958 N. Main Street
Mansfield, TX 76063

Tanner Electronics
1301 W Beltine
Carrollton, TX 75006

Electronic Parts Outlet
3753 B Fondren
Houston, TX 77063

Electronic Parts Outlet
17318 Highway 3
Webster, TX 77598

Washington

Amateur Radio Supply Co.
5963 Corson Ave., Ste 140
Seattle, WA 98108

If you'd like to sell our magazine in your store, please circle 210 on Free Information Card.

EQUIPMENT REPORT

FLUKE MODEL 77 III DMM

Fluke's 77 Series III DMM brings a fresh new look to the world of multimeters.

CIRCLE 15 ON FREE INFORMATION CARD

In terms of appearance, not much has changed over the years when it comes to common digital multimeters, or DMMs. Show any technician or experienced hobbyist any DMM from just about any manufacturer, and he or she will be instantly able to use it. That's because, for the most part , just about all DMMs look and work the same.

Why? Well, for one thing, most of the advances in meter technology have centered around performance and features, with styling, ergonomics, and the user interface taking a back seat for the most part. Besides, to most manufacturers it likely seems to make sense not to mess with a good thing.

It takes guts for a major manufacturer to change something that people are accustomed to, like the elimination of tail fins from cars in the early 1960s or the transition from analog multimeters to digital ones—customers just might not accept something that's new and different. That's why Fluke's move to change the design of a basic multimeter is a bold one. However, after having the opportunity to use one of the redesigned meters, this reviewer feels it is one that should be embraced by technicians worldwide. Fluke's 70 Series III and 20 Series III Digital Multimeters have a bold, new design that sets them apart from DMMs of the past and paves the way for more unusual designs in the future.

Electronics Now took a look at Fluke's model 77 III multimeter, a $179 DMM with a unique design that tapers down at the bottom making it easier to hold, especially for people with small hands. It also sports what Fluke calls an overmolded case. Fluke has basically taken the rubber holster that's been used on upscale DMMs in the past, and permanently fused it to the harder plastic case in what must be a really neat process. The result is a sleek multimeter with permanent cushioning around its outer surfaces. Fluke is confident that the meter is well protected because it's backed by a lifetime warranty. As long as the original purchaser owns it, Fluke will repair or replace it according to specified terms.

Anti-skid rubber feet, the same color as the case, are fused to the back of the meter—it's hard to see that they're there, but you can feel them and they do prevent the meter from sliding around while lying on a workbench or another surface. Making the outer cushioning a permanent part of the meter yields a slimmer, lighter instrument that's easier to work with. A flip-out hook on the back of the meter can be used to attach the meter to a vertical rod or cable, and there's a flip-out stand as well. The meter is $7\frac{3}{8}$ inches tall, $3\frac{1}{2}$ inches wide at the top, $2\frac{3}{4}$ inches wide at the bottom, and $1\frac{3}{8}$ inches high. It comes with a pair of rugged, non-slip, "rubberized" test leads.

The 77 III

High voltage is tough on a meter, but Fluke's 77 III DMM can take it. It has overvoltage protection against spikes up to 6 kilovolts—the meter is even safe if it's accidentally set to measure ohms. Model 77 III is IEC 1010 safety rated. This standard defines four overvoltage categories based on the magnitude of danger. The meter is rated for 6 kilovolts CAT I, 1000 volts CAT II, and 600 volts CAT III. The current inputs are fuse-protected.

The high-contrast LCD has been made 40% larger, with four digits measuring $\frac{5}{8}$-inches tall. The display has an analog bargraph along its bottom edge. A single rotary knob in the center of the meter is used to select the operating mode. The meter defaults to autorange mode, which can easily be overridden by pressing a Range button. A Touch-Hold mode automatically captures the measurement, beeps, and locks it on the display for later viewing.

Measurements for the 77 III DMM include AC and DC voltage up to 1000 volts, DC millivolts, resistance up to 32 megohms, and AC and DC current up to 10 amperes continuous. There's also a diode and audible continuity test.

A lot of unusual accessories are available from Fluke. Those include pin-grabber hooks, large-jaw alligator clips, an insulation piercing clip, industrial test leads, flexible straight test leads, an infrared temperature probe for non-contact temperature measurements, a thermocouple module, an immersion probe for liquids and gels, a stainless-steel piercing probe suitable for food service, an exposed probe for air and gas measurements, a pipe-clamp temperature probe, and more. Fluke is obviously prepared to take technicians into the next millennia with its new line of DMMs.

For more information on the model 777 Series III DMM, contact Fluke directly (Fluke Corporation, P.O. Box 9090, Everett, WA 98206; Tel: 800-44 FLUKE; Web: www.fluke.com), or circle 15 on the Free Information Card. EN

BY SAM GOLDWASSER
SERVICE EDITOR

CD Information Storage and Playback

BEFORE WE CAN GET INTO THE NITTY-GRITTY OF REPAIRING A CD PLAYER OR CD-ROM DRIVE, WE NEED A LITTLE MORE INFORMATION ON HOW CD INFORMATION STORAGE AND PLAYBACK WORKS. LET'S TACKLE THAT NEXT.

The actual information to be recorded on a CD undergoes a rather remarkable transformation as it goes from raw audio (or digital data) to microscopic pits on the disc's surface. For commercial or professional audio recording, the process starts with pre-filtering to remove frequencies above 20 kHz. It continues with analog-to-digital conversion, usually at a sampling rate of 48K samples/second for each stereo channel. The resulting data stream is then recorded on multi-track digital magnetic tape. All mixing and pre-mastering operations are done at the same sampling rate. The final step is conversion through re-sampling (sample-rate conversion including sophisticated interpolation) to the 44.1K samples/second rate actually used on the CD (88.2K total for both channels). (In some cases, all steps may be performed at the 44.1 K rate.) That is followed by sophisticated coding of the resulting 16-bit "two's-complement" samples (alternating between L and R channels) for the purpose of error detection and correction. Finally, the data is converted to a form suitable for the recording medium by Eight-to-Fourteen modulation (EFM) and then written on a master disc using a precision laser cutting lathe. A series of electroplating, stripping, and reproduction steps then produce multiple "stampers," which are used to actually press the discs you put in your player. Of course, it is possible to create your own CDs with a modest priced CD-R recorder (which does not allow erasing or re-recording), and now with re-writable CD technology with fully reusable discs that allow editing similar to what can be done using cassette tape.

Like a phonograph record, the information is recorded in a continuous spiral. However, with a CD, that track (groove or row of pits—not to be confused with the selections on a music CD) starts near the center of the CD and spirals counter-clockwise (when viewed from the label side) toward the outer edge. The readout is through the 1.2 mm polycarbonate disc substrate to the aluminized information layer just beneath the label. The total length of the spiral track for a 74-minute disc is over 5000 meters—which is more than 3 miles in something like 20,000 revolutions of the disc!

The digital encoding for error detection and correction is called the Cross Interleave Reed Soloman Code, or CIRC. To describe that as simply as possible, the CIRC consists of two parts: interleaving of data so that a dropout or damage will be spread over enough physical area (hopefully) to be reconstructed and a CRC- (Cyclic Redundancy Check) like error-correcting code. Taken together, those two techniques are capable of some remarkable error correction. The assumption here is that most errors will occur in bursts as a result of dust specs, scratches, or imperfections such as pinholes in the aluminum coating, etc. For example, the codes are powerful enough to totally recover a burst error of greater than 4000 consecutive bits—about 2.5 mm on the disc. With full error correction implemented (that is not the case with every CD player), it is possible to put a piece of 2-mm tape radially on the disc or to drill a 2-mm hole in the disc, and have no audio degradation. Some test CDs have just this type of defect introduced deliberately.

Two approaches are taken with uncorrectable errors: interpolation and muting. If good samples surround bad ones, then linear or higher-order interpolation might be used to reconstruct the bad samples. If too much data has been lost, the audio is smoothly muted for a fraction of a second. Depending on where those errors occur in relation to the musical context, even such drastic measures might be undetectable to the human ear.

Note that the error correction for CD-ROM formats is even more involved than for CD audio as any bit error is unacceptable. That is one of many reasons why it is generally impossible to convert an audio CD player into a CD-ROM drive. However, since nearly all CD-ROM drives are capable of playing music CDs, much can be determined about the nature of a problem by first testing a CD-ROM drive with a music CD.

Compact Disc Construction

As the following discussion proceeds, we will be expanding on some of the concepts introduced above.

The information layer uses "pits" as the storage mechanism. Pits are depressions less than 0.2 μm (1 μm = 0.001 mm = 0.000001 meter = 1/25,400 of an inch) in depth ($^1/_4$-wavelength of the 780-nm laser light, taking into consideration the actual wavelength inside the polycarbon-

ate plastic). Thus, the reflected beam is 180 degrees out of phase with incident beam making for high-contrast edges and good signal-to-noise ratio. Everything that is not a pit is a "land". Pits are about 0.5-μm wide; their length varies with the information content—with each bit being represented by a 0.278-μm increment.

Each byte of the processed information is converted into a 14-bit run-length-limited code taken from a code book (lookup table) such that there are no fewer than two or more than ten consecutive 0s between 1s. By then making the 1s transitions from pit to land or land to pit, the minimum length of any feature on the disc is no less than 3P and no more than 11P, where P is 0.278 μm. This is called Eight-to-Fourteen Modulation—EFM. Thus the length of a pit ranges from 0.833 to 3.054 μm.

Each 14-bit code word has 3 additional sync and low-frequency-suppression bits added, for a total of 17 bits representing each 8-bit byte. Since a single bit is 0.278 μm, a byte is then represented in a linear space of 4.72 μm. EFM in conjunction with the sync bits assures that the average signal has no DC component and that there are enough edges to reliably reconstruct the clock for data readout. These words are combined into 588-bit frames (see Table 1). Each frame contains 24 bytes of audio data (6 samples of L+R at 16 bits) and 8 bits of information used to encode (across multiple frames) information like the time, track, index, etc.

A block, which is made up of 98 consecutive frames, is the smallest unit that can be addressed on an audio CD and corresponds to a time of $^1/_{75}$ of a second. Two bits in the information byte of each frame are currently defined. These are called P and Q. P serves a kind of global sync function, indicating start and end of selections, time in between selections, and so forth. The 98 Q bits of each block encode the time, track and index number, as well as many other possible functions depending where on the disc it is located, what kind of disc it is, and so forth.

Information on a CD is recorded at a Constant Linear Velocity—CLV. That is both good and bad. For CD audio at 1× speed, this CLV is about 1.2 meters per second. (It really isn't quite constant—due to non-constant coding packing density and data buffering—but instead varies between about 1.2 and 1.4 meters-per-second). CLV permits packing the maximum possible information on a disc since it is recorded at the highest density regardless of location.

However, for high-speed access, particularly for CD-ROM drives, it means there is a need to rapidly change the speed of rotation of the disc when seeking between inner and outer tracks. Of course, there is no inherent reason why, for CD-ROMs, the speed could not be kept constant meaning that data transfer rate would be higher for the outer tracks than the inner ones. Modern CD-ROM drives with specs that sound too good to be true (and are), may run at constant angular speed achieving their claimed transfer rate only for data near the outer edge of the disc.

Note that unlike a turntable, the instantaneous speed of the spindle is not what determines the pitch of the audio signal. For one thing, there is extensive buffering in RAM inside the player. That buffering is used as a FIFO to smooth out data read off of the disc to ease the burden on the spindle servo, as well as to provide temporary storage for intermediate results during decoding and error correction. Pitch (in the music sense) is instead determined by the data readout clock—usually a crystal oscillator—which controls the D/A and LSI chip-set timing. The only way to adjust the player's pitch is to vary that clock. Some high-end players include a pitch adjustment that does just that.

Since the precision of the playback of a CD player is determined by a high-quality quartz oscillator, wow and flutter—key measures of the quality of phonograph turntables—are so small as to be undetectable. Ultimately, the sampling frequency of 44.1K samples-per-second determines the audio output. For this, the average bit rate from the disc is 4.321M bits-per-second.

Tracks are spaced 1.6-μm apart—a track pitch of 1.6. Thus, a 12-cm disc has over 20,000 tracks for its 74 minutes of music. Of course, unlike a hard disk and like a phonograph record, it is really one spiral track over 3 miles long! (However, as noted above, the starting point is near the center of the disc.) Compare that to an LP record: A long long-playing LP might have a bit over 72 minutes of music on two sides, or 36 minutes per side. (Most do not achieve anywhere near this much music since the groove spacing needs to vary depending on how much bass content the music has; bass requires wider grooves, and wide grooves occupy more space.) At 33-$^1/_3$ rpm, this is just over 1200 grooves in about 4 inches compared to 20,000 tracks on a CD in a space of just over 1.25 inches! The readout styles for an LP has a tip radius of perhaps 2 to 3 mils (50 to 75 μm)

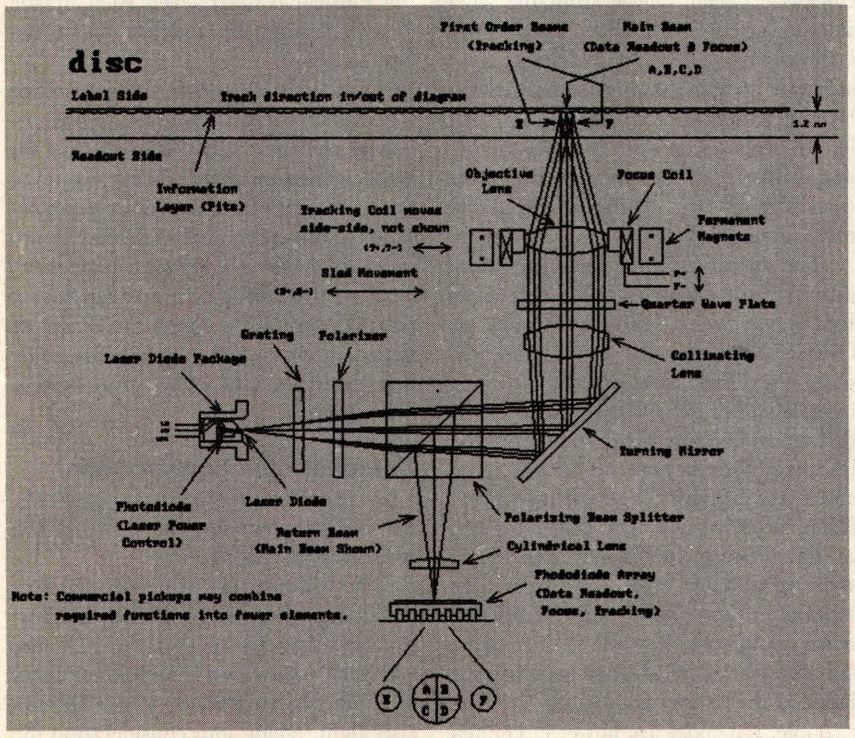


FIG. 1—HOW A TYPICAL THREE-BEAM PICKUP WORKS. Though there are many variations on this design, all pickups work in a similar fashion.

compared to 1 μm for the focused laser beam of a CD player!

At a constant linear velocity of about 1.2 meters per second, the required tracking precision is astounding. To put the required CD player servo-system performance into perspective, here is an analogy: Proper tracking of a CD is equivalent to driving down a 10-foot-wide highway (assuming an acceptable tracking error of less than +/-0.35 μm) for more than 3200 miles for one second of play, or over 14,400,000 miles for the entire disc without accidentally crossing lanes! And you thought that driving on a narrow winding country road was pretty tough!

Actually, it is worse than that: Focus must be maintained all this time to better than 1 μm as well (say, +/-0.5 μm). So, it is more like piloting a aircraft down a 10-foot-wide flight path at an altitude of about 12 miles (4 mm (typical) focal-length objective lens) with an altitude error of less than +/-7 feet while the target track below you is moving both 1 mile horizontally (CD and spindle run-out of 0.35 mm) and 3 miles vertically (disc warp and spindle wobble of up to 1 mm) per revolution! In addition, you are trying to ignore various types of garbage (smudges, fingerprints, fibers, dust, etc.) below you, which on this scale have mountain-sized dimensions. (Sorry for the mixed units, and my apologies to the rest of the world where the proper units are used for everything.)

The required precision seems unbelievable, but is just another day in the entertainment center for the CD player's servo systems. Even more surprising, this level of precision is achieved using mass-produced technology that dates to the late 1970s. And, don't forget that a properly functioning CD player is remarkably immune to small bumps and vibration—more so than an old style turntable.

Of course, we better hope that our technological skills are never lost—a phonograph record can be played using the thorn from a rosebush and a potter's wheel for a turntable. As you can see, there's just a bit more technology needed to read and interpret the contents of a CD!

Optical-Pickup Principles

The purpose of the optical pickup in a CD player, CD-ROM drive, or optical-disk drive, is to recover digital data from the encoded pits at the information layer of the optical medium. For CD players, the resulting data stream is converted into high-fidelity sound. For CD-ROMs or other optical-storage devices, it might be interpreted as program code, text, audio or video multimedia, color photographs, or other types of digital data.

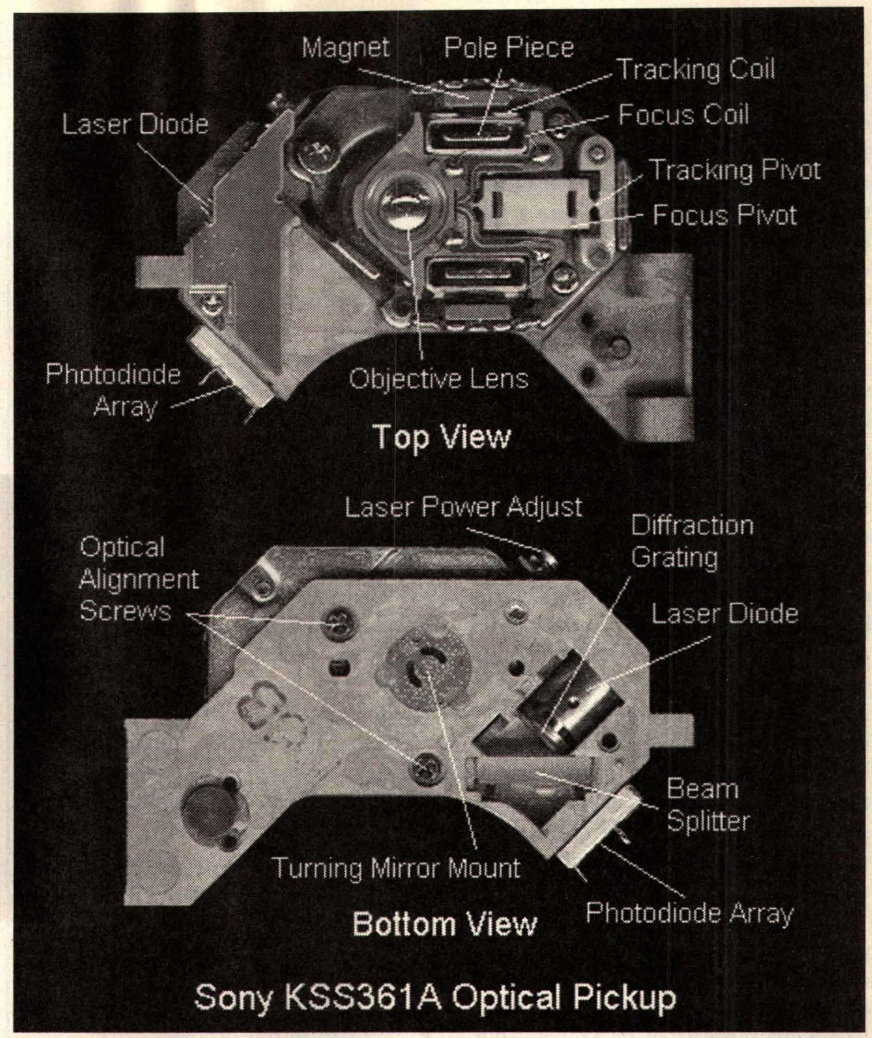


FIG. 2—THIS SONY KSS361 is a typical mass-produced modern pickup. It combines multiple functions into fewer distinct parts, resulting in improved robustness and lower cost.

The following (simplified) description of an optical pickup assumes a three-beam device—the most common type. A diagram of the pickup we will be discussing is shown in Fig. 1. To accomplish the same objectives, many variations on this design—such as a single-beam pickup—are possible. In addition, modern mass-produced pickups like the very common Sony KSS361A model shown in Fig. 2 combine multiple functions into fewer distinct parts. The result is improved robustness and lower cost. However, most of the basic operating principles are similar.

It is often stated that the laser beam in a CD player is like the stylus of a phonograph turntable. While this is a true statement, the actual magnitude of this achievement is usually overlooked. Consider that the phonograph stylus is electromechanical. Stylus positioning—analogous to tracking and focus in an optical pickup—is based on the stylus riding in the record's grooves and controlled by the suspension of the pickup-cartridge and tone arm. The analog audio is sensed most often by electromagnetic induction produced by the stylus's minute movements wiggling a magnet within a pair of sense coils.

The optical pickup, on the other hand, must perform all of those functions without any mechanical assistance from the CD. It is guided only by a fraction-of-

TABLE 1

Sync	(24 + 3)
Control and Display	(14 + 3)
Data	(12 × 2 × (14 + 3))
Error Correction	(4 × 2 × (14 + 3))
Total Bits/Frame	588

a-mW of laser light and a few milligrams of silicon-based electronic circuitry. Furthermore, the precision involved is easily more than two orders of magnitude finer than that required for a phonograph. Sophisticated servo systems maintain focus and tracking to within a fraction of a micrometer of optimal. Data is read out by detecting the difference in depth of pits and lands of $^1/_4$-wavelength of laser light (about 0.15 μm in the CD)!

The laser beam is generated by a solid-state laser diode emitting at 780 nm (near IR). Optical power from the laser diode is no more than a couple of mW and exits in a wedge-shaped beam with a typical divergence of 10 × 30 degrees in the X and Y directions, respectively. A diffraction grating splits the beam into a main beam and two (first-order) side beams. (The higher-order beams are not used.) Note that the diffraction grating is used to generate multiple beams, not for its more common function of splitting up light into its constituent colors. The side beams are used for tracking and straddle the track that is being read. The tracking servo maintains this centering by keeping the amplitude of the two return beams equalized.

Next, the laser beam passes through a polarizing beam splitter (a type of prism or mirror that redirects the return beam to the photodiode array), a collimating lens, a quarter-wave plate, a turning mirror, and the objective lens before finally reaching the disc.

The collimating lens converts the diverging beam from the laser into a parallel beam. A turning mirror (optional, depending on the specific optical path used) then reflects the laser light up to the objective lens and focus/tracking actuators.

The objective lens is similar in many ways to a high-quality microscope objective lens. It is mounted on a platform that provides for movement in two directions. The actuators operate similarly to the voice coils in loudspeakers. Fixed permanent magnets provide the magnetic fields that the coils act upon. The focus actuator moves the lens up and down. The tracking actuator moves the coil in and out with respect to the disc center. The collimated laser beams (including the 2 side beams) pass through the objective lens and are focused to diffraction-limited spots on the information-pits layer of the disc (after passing through the 1.2 millimeters of clear polycarbonate plastic that forms the bulk of the disc).

The reflected beam retraces the original path up until it passes through the polarizing beam splitter, at which point it is diverted toward the photodiode array. (The polarizing beam splitter passes the horizontally polarized laser beam straight through. However, two passes—source and return—through the quarter-wave plate rotates the polarization of the return beam to be vertical instead, and it is reflected by the polarizing beam splitter toward the photodiode array.)

A cylindrical lens slightly alters the horizontal and vertical focal distances of the resulting spot on the photodiode array. The spot will then be perfectly circular only when the lens is positioned correctly. Too close or too far and the spot will be elliptical (*e.g.*, elongated on the 45-degree axis if too close, and elongated on the 135-degree axis if too far). The main return beam from the disc's information layer is used for servo control of focus and tracking, and for data recovery. The actual implementation could use an astigmatic objective lens rather than a separate cylindrical lens to reduce cost, but the effect is the same. Since the objective lens is molded plastic, it costs no more to mold an astigmatic lens (though grinding the original molds might have been a treat!). It is even possible that in some cases, the natural astigmatism of the laser diode itself plays a part in this process.

In essence, the optical pickup is an electronically steered and stabilized microscope that is extracting information from tracks $^1/_{20}$ the width of a human red blood cell while flying along at a linear velocity of 1.2 meters per second!

Now that you know everything (almost) there is to know about how CDs are made and work, we will wind up our theoretical discussion and go on to the good stuff, how to fix a player or a drive when it is broken. Tune in next time for our first CD troubleshooting segment. In the meantime if you have any problems or questions that just can't wait, go to my Web site at www.repairfaq.org. For questions to me, address them to me via e-mail at sam@stdavids.picker.com. (Note: While I would love to answer all your questions, regrettably, the finite number of microseconds in a day prevents me from being able to reply to letters sent via the postal service. However, I will respond to all e-mail requests in a timely manner—usually within 24 hours. Thanks for your understanding in this.)

See you next time. EN

COMPUTER CONNECTIONS

continued from page 11

forming (software) system upgrades;

- Provides instant-on; and
- Returns to previous activity on power-up.

All those things, and some that I've undoubtedly overlooked, are part of the user interface, the overall *gestalt* referred to above. All are things that people like us routinely handle, perhaps because the technical details are (or were initially) interesting to us, perhaps because it's part of our job description, or perhaps because we simply accept it as the price we have to pay to do what we really want to do. But what about the other 99.5% of humanity?

The Pilot doesn't do all the things listed. But it does most, in its small way. So what happens if the Pilot gets bigger, if it scales up, and maintains those attributes? That's why Microsoft is scared. That's why the race isn't over. That's why ideas like NetPCs and network computers are still compelling for some applications. They can present a focused, robust, reliable user interface—if not a universal one.

Microsoft and Intel are seemingly unassailable in their present positions. But Windows so far has failed as a PDA UI, and I have trouble seeing it as a "Toaster-User Interface," either.

1997 may well have been the beginning of the end for Wintel. There are chinks in the armor, some big enough to fly a space shuttle through, and the success of the Pilot shows that new *platforms* can thrive. Believe it or not, it is still possible that the market could eventually just discard Wintel as yet another stepping stone on the way to the future.

I don't think anyone doubts the ubiquity of computer technology in this future. But the precise shape of the technology is still to be determined. I am utterly certain, however, that bloated, slow, confusing, and vulnerable are not going to be attributes of this technology. To the extent that Wintel continues supplying products with those attributes, there is that much more opportunity for innovative new platforms.

Wintel could close the gaps before it's too late. But it may not. Time will tell.

We've closed out our sole-focus tutorial on PalmPilot programming for now. Though we'll be returning to the PalmPilot on occassion, it's time to explore some fresh topics, which we'll begin next time. EN

NEW PRODUCTS

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

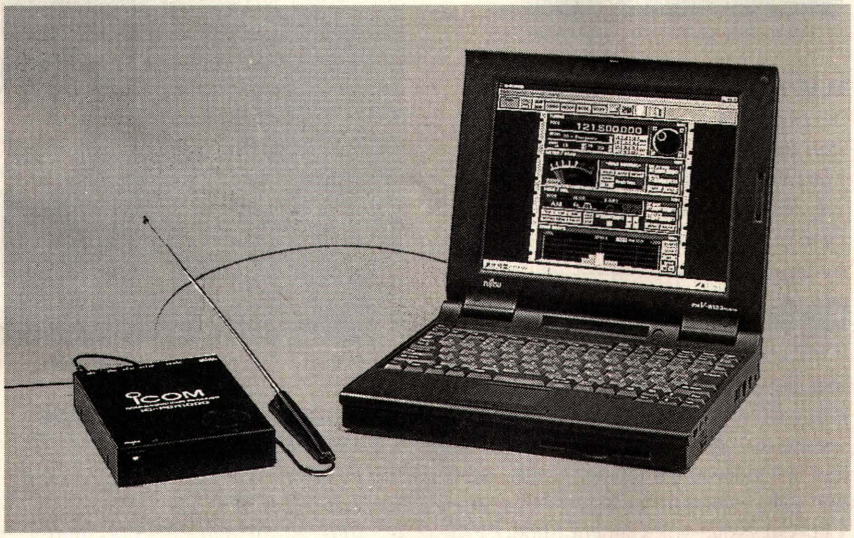
World-Wide Radio

THE IC-PCR1000 IS A "BLACK-BOX" communications device that transforms a personal computer into a high-quality wide-band communications receiver. Compatible with many different PC models, even laptops, the PCR-1000 connects to computers externally and offers both "band-scope" functions and exceptional receiver/scanner performance.

The device receives local radio and TV broadcasts, as well as shortwave broadcasts that carry data transmissions, news, music, and events from other countries—such as BBC shows or rugby matches from Australia. In addition, PC users are able to listen to or "scan" public safety (fire, police, search and rescue), commercial, military, aircraft, and marine communications. For mobile reception, it can be used in a car simply by connecting it to a laptop and using the power from a 12-volt cigarette lighter.

Featuring three receiver-interface screens (a communications-receiver screen, a component-type screen, and a radio screen), it works while other programs are in use. There is an unlimited number of memory channels, grouped into banks of 50 channels each that can be stored on either the hard drive or on a floppy. Each memory stores frequency, receive mode, memory names, tuning steps, and attenuator and filter settings.

The size of a small hard-bound novel, this "black-box" receiver covers a wide frequency range from 0.01 to 1300 MHz, with all-mode receive capability, including WFM, FM, AM, SSB, and CW. The IC-PCR1000 has a suggested list price of $599.



CIRCLE 20 ON FREE INFORMATION CARD

ICOM AMERICA, INC.
2380 116th Ave., N.E.
P.O. Box C-90029
Bellevue, WA 98009-9029
Tel: 425-454-8155
Fax: 425-454-1509
Web: www.icomamerica.com

Versatile Tester

A COMPACT, RUGGED, ALL-trade, general-purpose meter, the Model DM7 is designed for basic electronic and electrical troubleshooting, testing, and measurement. Its small size (5.5- × 3.1- × 1.6-inches) makes it practical for portable testing anywhere: for field-service applications or as an easy-to-use meter for around the home, garage, or workshop.

CIRCLE 21 ON FREE INFORMATION CARD

Measurement capabilities of this DMM include AC voltage, DC voltage, DC current, resistance, and battery testing. Features of the DM7 include a 2000-count precision digital readout, AC/DC ranges to 600 volts, DC current to 200mA, four resistance ranges to 2 megohms, diode testing, and a quick battery tester for 1.5- and 9-volt batteries.

The Model DM7 digital multimeter comes with safety test leads and protective holster. It retails for $29.95.

WAVETEK CORP.
9045 Balboa Avenue
San Diego, CA 92123
Tel: 800-854-2708 or 619-279-2200
Fax: 619-565-9558
Web: www.wavetek.com

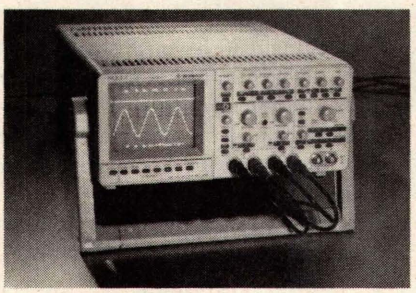
Differential Oscilloscope

PROVIDING THE BENEFITS OF A full-function analog, digital-storage, and differential oscilloscope, the Model 5034 30MHz Differential Oscilloscope is capable of measuring motor-control circuits, switching power, 3-phase power, and high common-mode voltages. It offers direct viewing of line voltages, safe from the hazards of "hot chassis" equipment.

The 5034 measures small signals superimposed on high AC or DC voltages by using one differential input to reference the common mode voltage. The instrument allows phase analysis of multi-phase systems. In the differential mode, full sensitivity is provided from 10mV/div to 200V/div.

Its dual-channel capability includes functioning as a dual-trace scope in the differential mode with full differential inputs on both channels and external trigger input. Among the features of the 5034 are digital refresh at 0.1µs to 200s/div, 40-MHz sampling frequency, and sweep speed of 0.2µs/div to 200ms/div in 1-2-5 sequence, 20 positions.

An RS-232 port enables hard copy and remote programming. It features 8K memory, autoset, and display cursors/readouts. Compact in size, the unit's 6-inch CRT display offers 8-bit (256-level) resolution. The 5034 is priced at $2330.



CIRCLE 22 ON FREE INFORMATION CARD

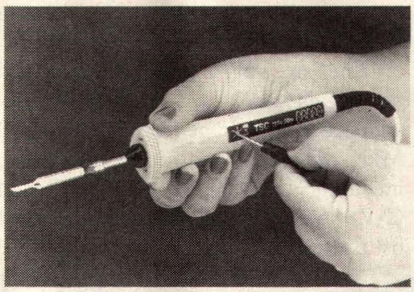
B+K PRECISION
4353 West Lawrence Avenue
Chicago, IL 60630
Tel: 773-725-9252
Fax: 773-725-9385
Web: www.bkprecision.com

Adjustable Soldering Iron

A COMPLETELY SELF-CONtained soldering iron, the Antex Model TCS Temperature-Controlled Soldering Iron features an adjustment screw on the handle for setting tip temperatures to the optimum heat level. The screw, which adjusts using a small screwdriver, can set the temperature from 390°F to 850°F with ±1% stability (typical).

Eliminating the need for a separate soldering station, this standard-size iron has a tapered plastic handle that fits the hand comfortably. It is well-suited for use in electronic assembly and field-service operations.

The Model TCS Soldering Iron has zero-voltage switching, heats up to 650°F in less than a minute, and provides rapid recovery time. A wide selection of slide-on tips is offered. There are two versions available: a 115-volt AC model and one for 24-volt power supplies. The Antex Model TCS Temperature-Controlled Soldering Iron lists for $77.42.



CIRCLE 23 ON FREE INFORMATION CARD

M.M. NEWMAN CORPORATION
24 Tioga Way
P.O. Box 615
Marblehead, MA 01945
Tel: 781-631-7100
Fax: 781-631-8887

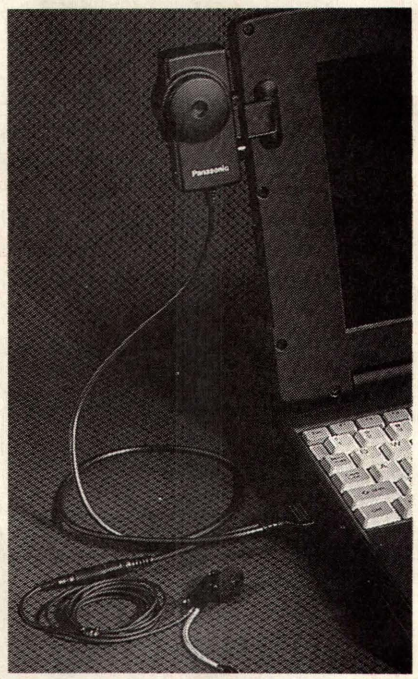
Clip-On Notebook Video Camera

THIS COLOR VIDEO CAMERA that clips to a notebook's display and plugs into a PC-card slot can be used by laptop owners to create and send video e-mail and for videoconferencing. Unlike other portable cameras in its class, the Panasonic Clip-On Notebook Camera (model PM-S122) offers full-duplex sound for telephone-like audioconferencing.

It is one of the first complete, easy-to-use videoconferencing systems designed for use with a laptop. Both camera and headset connect to an included conference card that plugs directly into any PCMCIA Type II slot. The headset includes earphone and adjustable microphone.

Measuring 3.1 by 1.7 by 1.2 inches, the camera is smaller than a business card. It produces images with a resolution of 542 × 497 and 300 TV lines. When clipped to the left side of a notebook's flip display, the camera swivels up to 40 degrees, and tilts up to 120 degrees, making it easy to frame a subject's face. It includes an automatic gain control and automatic white balance for optimum color fidelity, and has an adjustable-focus lens.

The advanced compression techniques of the bundled software allows PM-S122 users to create and send A/V messages as e-mail attachments. Other included software allows real-time A/V communication between two or more people, via a standard phone line, the Internet, or over a LAN. System requirements are Windows 95 and a minimum of 16MB of memory. The PM-S122 Clip-On carries an estimated street price of $549.



CIRCLE 24 ON FREE INFORMATION CARD

PANASONIC COMMUNICATIONS & SYSTEMS COMPANY
Two Panasonic Way
Secaucus, NJ 07094
Tel: 800-742-8086 or 201-348-7000
Web: www.panasonic.com/alive

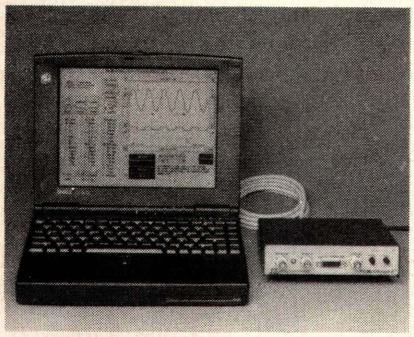
Virtual Instruments

THE MISSION TECHNOLOGY PC-MultiScope2, from Amaze Electronics, when connected to a personal computer, can replace an entire lab of bench equipment. The device transforms any PC into a full-function digital storage oscilloscope, spectrum analyzer, strip-chart recorder, digital voltmeter, and adjustable DC power supply. With an optional module, it also serves as a function generator.

The PC-MultiScope2 is easy to install

and use. It connects to a PC through the parallel port and has a Windows 3.1/95 user interface. Weighing less than two pounds, it can be used in the lab, at home, or in the field.

The PC-MultiScope2 costs $399.



CIRCLE 25 ON FREE INFORMATION CARD

AMAZE ELECTRONICS CORPORATION
4575 Grimsby Drive
San Jose, CA 95130
Phone: 800-996-2008
Fax: 408-374-1737
E-mail: amaze@hooked.net
Web: http://www.hooked.net/users/amaze

Pint-Sized 103 CD-ROM Drives

ACCORDING TO ADDONICS Technologies, its PCMCIA PocketCD and Parallel PocketCD portable CD-ROM drives are smaller, lighter, and faster than any other product on the market. Each measures 5.5 by 5.3 by 0.7 inches and weighs 15 ounces. Average access time is 190 ms, average data-transfer rate is 1.5 MB/s (103), and maximum data transfer rate is 1.8 MB/s (123).

In the same space as two standard CD jewel cases, the PCMCIA PocketCD contains a 103-speed CD-ROM drive, internal rechargeable batteries, a PCMCIA interface, a mini-headphone jack, and controls for audio CD playback. The device can be powered from a laptop computer's battery through its PCMCIA interface, through its batteries, or from an external power adapter (sold separately). A parallel interface is also available as an option. Designed for the mobile professional who needs access to his CD-ROM drive everywhere, the PCMCIA PocketCD can also be used as a portable CD player.

The Parallel PocketCD, for people who want portability but primarily use their CD-ROM drive where line power is available, differs from its sibling in its power source and standard interface. This drive comes with an internal compartment for four "AA" batteries, a parallel-port interface, a mini-headphone jack, and controls for audio CD playback. A 5-volt power adapter is included.

The PCMCIA PocketCD and Parallel PocketCD have suggested retail prices of $399 and $349, with expected street prices of $349 and $299, respectively.

CIRCLE 26 ON FREE INFORMATION CARD

ADDONICS TECHNOLOGIES
48434 Milmont Drive
Fremont, CA 94538
Tel: 510-438-6530
Fax: 510-353-2020
E-mail: Atc@addonics.com
Web: http://www.addonics.com

Digital Triple-Output Power Supply

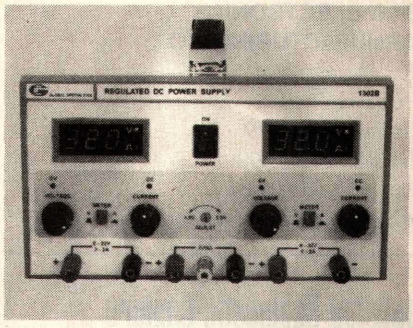
OFFERING DIFFERENT VOLTAGE and current outputs, the Model 1302B Triple Output constant-current /constant-voltage DC Power Supply by Global Specialties is designed for industrial and laboratory use. A fully-regulated power supply, it meets all DC voltage requirements. It is used for product development, analog-and digital-circuit design, product development, testing, quality control, servicing, and education.

The two main outputs are continuously variable from 0 to 32 volts and can each supply 2 amps maximum. They can be operated in constant-voltage or constant-current modes. In addition, a separate 5-volt output provides variable 4.5- to 5.5-volts DC power at 5 amps.

Separate front-panel meters are provided to monitor output voltage and load current for the 32-volt sections. Green LED digital displays make the meters easy to read. Switch selection enables either voltage or current monitoring for each section.

Automatic overload and short-circuit protection is built in. Additional protection is provided by the isolated design of the heavy-duty transformers.

The compact, fully solid-state instrument measures 9 × 11.5 × 5.5 inches, and is priced at $595.



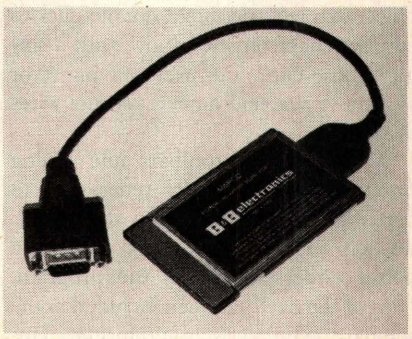
CIRCLE 27 ON FREE INFORMATION CARD

GLOBAL SPECIALTIES
70 Fulton Terrace
New Haven, CT 06512
Tel: 800-572-1028 or 203-466-6103
Fax: 203-468-0060

Serial Port for Your Laptop

ADDING B&B ELECTRONICS' 485PCC PCMCIA card to your laptop provides it with an RS-422/485 serial port. This single card can be configured for either an RS-422 orRS-485 port, and for high speed and normal communications.

The Type-II (5 mm) PCMCIA card is ideal for field-service representatives who work on numerous configurations. It features Automatic Send Data control, which handles RS-485 driver enable and disable functions transparently, allowing easy use with Windows 95 and software without RTS support. Users can also set the 485PCC to 4× clock mode, which allows baud rates up to 460.8K. A 16550UART offers high-speed communications with reduced CPU overhead. Pinouts of the 485 match the SMPTE video standard for controlling devices.



CIRCLE 28 ON FREE INFORMATION CARD

Only You Can Prevent Forest Fires.
Ad Council
SMOKEY

A simple configuration program is shipped with the card, and configuration options are stored in non-volatile memory. The 12-inch cable included with the card has a D89 male connector. The 485PCC PCMIA Serial Port Card is priced at $159.95

B&B ELECTRONICS MANUFACTURING CO.
707 Dayton Road
P.O. Box 1040
Ottawa, IL 61350
Tel: 815-433-5100
Fax: 815-434-7094
Web: http://www.bb-elec.com

Updated Schematic-Capture Software

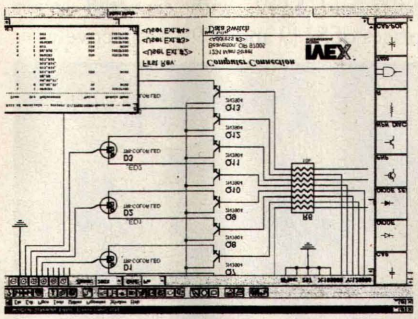
VERSION 2.0 OF WINDRAFT Schematic Capture software from Ivex Design International features a new "Parts Palette" that allows the user to select up to 20 frequently used parts. The Palette appears on the screen next to the worksheet, where the user can just click on a part and then click on the sheet to place it. The user can scroll through the Palette with the standard Windows scroll bar. Parts can be easily added or deleted from the Palette. The user can even customize the order of the parts after they have been placed in the Palette.

Another new feature is the ability to import BMP graphic files, which can now be used to customize the title block with a logo or to import other graphic designs onto a worksheet. True-type fonts have been added throughout the program, including title block, pin numbers, references, values, and hierarchical sheet symbols. In past versions of WinDraft, true-type fonts were available only on comment text.

Editing functions have been revised to be more natural and to conform to the format used with the Ivex WinBoard PCB layout program. Single-click on an object to select and move; double-click to edit the characteristics. Now, with a single mouse-click, the user can insert or move a vertex, and quickly reroute wires or buses.

WinDraft 2.0 toolbars and dialog boxes have been totally redesigned to better organize information and setups. To help the less experienced user get a better understanding of the program, "tips of the day" has been included in the standard Windows start-up format. Tips include answers to the most frequently asked questions about the product and shortcuts to commands.

The unlimited pin capacity version of WinDraft 2.0 costs $495, and the 650-pin version costs $240. Registered customers will be notified as to the upgrade cost. A free shareware version of either WinDraft or WinBoard can be obtained from the Web site listed below. The shareware versions are complete, fully-functional programs with a 100-pin/pad limitation and can be used to view any size design.



CIRCLE 29 ON FREE INFORMATION CARD

IVEX DESIGN INTERNATIONAL
15232 NW Greenbrier Parkway
Beaverton, OR 97006-5746
Tel: 503-531-3555
Fax: 503-629-4907
E-mail: info@ivex.com
Web: http://www.ivex.com.

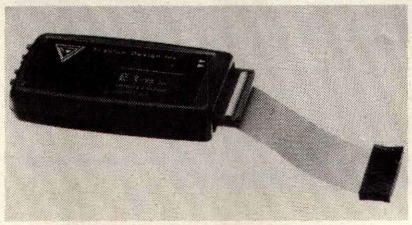
Memory Emulators

OFFERING ENHANCED FEATures, Scanlon Design Inc.'s E-Series emulates EPROM, FLASH, ROM, and static RAM memory devices from 8K×8–128K×8 (E1) to 8K×8–1024K×8 (E8). Live editing, live watches, and advanced debugging are featured in the emulators. The software lets the user see SRAM variables change and allows the editing of run-time data to force conditions and fully test embedded systems.

All the models provide reading and writing at full speed and simultaneous live viewing and editing from the host PC. Software debugging features such as memory-mapped bi-directional communication and third-party remote-debugger support allow the target system to pass debugging information back to the host PC. The E-Series also offers error checking and correction while downloading (420 kbps), has an access time of 70 ns, and draws a maximum current of only 5 mA from the target system,

These products feature simple hook-up and connection for up to four emulators, multiple output signals for control of the target system, and memory back-up for power-up emulation. Each emulator comes with 28- and 32-pin DIP adapters. Also available are 32-pin PLCC adapters, as well as low-voltage models that allow operation from 2.7 to 5.5V.

The E-Series emulators are priced from $199 for the E1-70 to $369 for the E8LV-90.



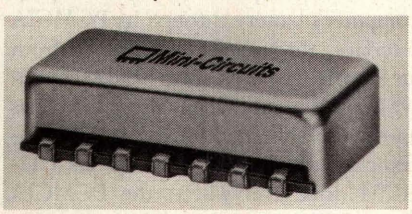
CIRCLE 30 ON FREE INFORMATION CARD

SCANLON DESIGN INC.
5224 Blowers Street
Halifax, N. S.
Canada B3J 1J7
Tel: 800-352-9770 or 902-425-3938
Fax: 902-425-4098
E-mail: info@scanlondesign.com
Web: www. scanlondesign.com

Wide-Band VCO

MINI-CIRCUITS' JTOS-1025 WIDEband VCO is a low-cost surface-mount, voltage-controlled oscillator. This high-performance VCO features a wide range of linear tuning (685–1025 MHz) , -28 dBc harmonic suppression, and low -70 dBc/Hz SSB phase noise at 1 kHz offset (typical). Tuning voltage is 1-16 volts (absolute maximum is 20 volts).

This VCO is housed in a rugged metal case with solder-plated J leads for superior mechanical integrity. Uses include measurement instrumentation and PLL circuitry applications. The JTOS-1025 is priced at $18.95 each (quantity 5-49), with immediate off-the-shelf availability.



CIRCLE 31 ON FREE INFORMATION CARD

MINI-CIRCUITS
P.O. Box 350166
Brooklyn, NY 11235-0003
Tel: 718-934-4500
Fax: 718-332-4661
Web: http://www.minicircuits.com

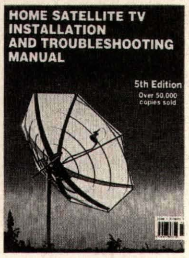
EN

NEW LITERATURE

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

Home Satellite TV Installation and Troubleshooting Manual 5th Edition

by Frank Baylin with Brent Gale and Ron Long
Baylin Publications
1905 Mariposa Blvd.
Boulder, CO 80302
Tel: 800-483-2423
Web: www.baylin.com
$30 plus $4 S & H



CIRCLE 338 ON FREE INFORMATION CARD

Written in a style that can be easily understood by an interested layman, this 326-page manual is an invaluable working tool designed to make selecting, installing, and maintaining large-dish satellite systems easy. Largely rewritten and re-organized, this fifth edition of the book contains over 300 up-to-date illustrations, photographs, and tables, and includes background theory and details on how satellites and TVROs operate, as well as methods to select and judge satellite TV components.

There is a detailed step-by-step installation and dish-aiming guide with all the necessary charts and tables, thorough diagrams and text explaining conventional and IF multiple-receiver and multiple-television hookups, and methods to install unusually large dishes. In addition, readers are shown a complete strategy and details on troubleshooting any satellite TV system.

Complete explanations of the MPEG-2 digital television standard, video compression methods, IF distribution of satellite signals, and a brief overview of digital link analysis are presented. The appendix includes a useful collection of equations, a glossary, and a complete list of satellite equipment manufacturers, as well as reference books and magazines.

1998 Test & Measurement Accessories Catalog

ITT Pomona Electronics
1500 E. 9th Street
Pomona, CA 91766-3835
Tel: 909-469-2900
Fax: 909-629-3317
Web: www.ittpomona.com
Free

CIRCLE 339 ON FREE INFORMATION CARD

This 50th anniversary catalog presents the full line of Pomona test and measurement accessories. A complete range of coaxial cable assemblies and adapters, patch cords, enclosures and boxes, IC test clips for 2- and 4-sided devices, and static control products are among the items included in the 92-page catalog.

Highlighted are newly designed DMM accessories, a new family of high-performance oscilloscope probes, and the first IEC1010-compliant mini-grabber ever offered. The redesigned DMM accessories are featured in ITT Pomona's Test Companion Kits, which are compatible with Fluke, Hewlett-Packard, Tektronix , and Wavetek DMMs and oscilloscopes. The mini-grabber's slim-line design allows easier access with today's more-densely populated test situations. It is paired with a right-angle plug, a straight plug, a banana jack, a multi-stacking banana plug, or another mini-grabber to create eight distinct patch cords.

Also featured are ×1/×10 Passive Oscilloscope Probes offering dual-band-width performance for greater text flexibility, a $^{7}/_{16}$ DIN Adapter Kit improving intermodulation performance, and a push-on BNC 50-ohm cable.

BooksNow To order books in this magazine or, any book in print. Please call anytime day or night: **(800) BOOKS-NOW (266-5766)** or (702) 258-3338 ask for ext. 1456 or visit on the web at **http://www.BooksNow.com/electronicsnow.htm.**

Optoelectonic Packaging

Edited by Alan R. Mickelson, Nagesh R. Basavanhally, and Yung-Cheng Lee
John Wiley and Sons, Inc.
605 Third Avenue
New York, NY 10158-0012
Tel: 212-850-6336
$74.95

CIRCLE 340 ON FREE INFORMATION CARD

The rapidly expanding field of packaging for optoelectronic devices presents the engineer with complicated problems to solve. One major challenge is how to assemble an array with many elements efficiently, while maintaining thermal tolerance and simultaneously overcoming electrical-noise problems. Designed for professionals in the field, *Optoelectronic Packaging* is the first source book available on optoelectronic-assembly techniques.

The book provides an overview of current state-of-the-art technologies, packages that are now on the drawing board, and the future direction of packaging. It also explains the fundamentals of optics and packaging.

Featuring contributions from expert practitioners in the field and numerous illustrations, the text covers the subject of assembly technologies. It explains detector, semiconductor laser, and optical-amplifier packaging. Waveguide and hybrid technologies are discussed. The book also examines communication-system interconnection structure and fiber-optic networks in telecommunications. Case studies of packaged subassemblies are also included.

Bigelow's Computer Repair Toolkit

by Stephen J. Bigelow
McGraw-Hill
11 West 19th Street
New York, NY 10011
Tel: 800-2MCGRAW
$39.95

CIRCLE 341 ON FREE INFORMATION CARD

This book is the first to bring together over 100 shareware and public-domain diagnostics and utilities on a single disk: the DLS Diagnostic CD (included with the book). The book and CD combine to give technicians a "Swiss army knife" of tools to aid in troubleshooting or upgrading computers.

Divided into nine chapters, the book explains why, when, and how to use these diagnostic programs. The first chapter gives an overview of the shareware. The subsequent six chapters give highlights of the programs: general PC hardware tools, video systems, printers and parallel-port tools, modem and communications tools, drive tools, and general support tools. The last two chapters discuss the commercial diagnostics included on the CD.

1997 Technical Library, 2nd Edition

Microchip Technology, Inc.
2355 W. Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 602-786-7668
Web: www.microchip.com
Free

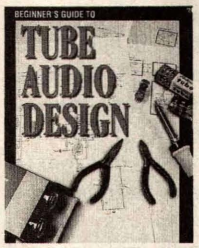
CIRCLE 342 ON FREE INFORMATION CARD

This CD-ROM contains technical literature on Microchip's PICmicro 8-bit RISC-based microcontrollers, non-volatile memory devices, ASSPs, secure data products, and associated development tools. Included are: the *In-Circuit Serial Programming Guide*, application notes, data sheets, third-party guide, development-systems software, users' guides, packaging diagrams and parameters, and worldwide sales and service information.

Microchip products target thousands of embedded control applications in the consumer, automotive, office automation, communications, and industrial markets.

Beginner's Guide to Tube Audio Design

by Bruce Rozenblit
Audio Amateur Corporation
Old Colony Sound Laboratory
P.O. Box 243
Peterborough, NH 03458-0243
$24.95



CIRCLE 343 ON FREE INFORMATION CARD

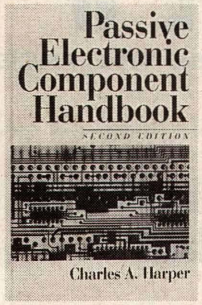
This beginner's guide describes what vacuum tubes do and how to use them. It shows readers how to design the building blocks that turn tubes, transformers, and other hardware into amplifiers.

After beginning with tube basics, the author then goes on to explain their characteristics and how to read charts and specifications. In a systematic manner, a complete explanation of audio design is provided for more advanced readers—from single one-stage amplifiers to multistage basics and variations such as triode and ultralinear operation. Complete instructions for building three working projects are provided at the end of the book.

Other chapters cover a simple-gain circuit; negative feedback and how to use it; power sources for the amplifiers, how they work, and how to build them; stabilization and testing; and a description of 13 classic amps and pre-amps. There are also tips on working effectively as a designer, construction techniques, and choosing tools and components.

Passive Electronic Component Handbook: 2nd Edition

Edited by Charles A. Harper
McGraw-Hill, Inc.
11 West 19th Street
New York, NY 10011
Tel: 800-2MCGRAW or 212-337-5951
Fax: 212-337-4091
Web: www.ee.mcgraw-hill.com
$89.50



CIRCLE 344 ON FREE INFORMATION CARD

The fully updated and revised edition of this comprehensive standard reference on passive electronic components is the first one in fifteen years. The revision, written by experts in the field, gives quick, reliable, one-volume access to critical characteristic data, performance curves, and design guidelines. (A companion volume covers active components.)

The full range of component technologies is covered, including resistors, capacitors, transformers, relays and switches, batteries, fuse and protective components, filters and transient voltage-protection devices, wiring and cabling, and connectors and cabling devices. The source book also offers test and reliability data; listings of specifications and standards; and information on dimensions, configuration, and mechanical and functional performance.

The 786-page handbook provides engineers, designers, and technicians with the practical data needed to more effectively select optimal components in virtually any electronics system.

Mobile Data & Wireless LAN Technologies

by Rifaat A. Dayem
Prentice Hall
One Lake Street
Upper Saddle River, NJ 07458
Tel: 800-382-3419
Web: www.prenhall.com
$55

CIRCLE 345 ON FREE INFORMATION CARD

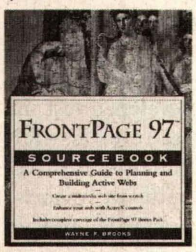
Designed for engineers, networking professionals, and mangers, this is a state-of-the-art guide to where wireless data stands now and what to expect tomorrow. It presents detailed technical and business information for every leading and emerging wireless LAN and WAN technology,

BooksNow To order books in this magazine or, any book in print. Please call anytime day or night: **(800) BOOKS-NOW (266-5766)** or (702) 258-3338 ask for ext. 1456 or visit on the web at **http://www.BooksNow.com/electronicsnow.htm.**

The author reviews potential applications, market forecasts, and key players. Technologies covered include spread spectrum, packet radio, infrared, CDPD, two-way paging, and MAC protocols for wireless networks. Other technologies discussed are mobile IP, 802.11, Hyperlan, wireless ATM, and data-over-circuit-switched solutions. In addition, there is a primer on wireless networking, and information on mobile data, wireless spectra, and international standards.

FrontPage 97 Sourcebook

by Wayne F. Brooks
John Wiley & Sons, Inc.
605 Third Avenue
New York, NY 10158-0012
Tel: 800-225-5945
Web: www.wiley.com/compbooks/
$29.95



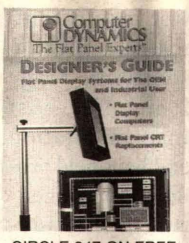
CIRCLE 346 ON FREE INFORMATION CARD

FrontPage 97 lets you combine graphics, text, audio, and video in your web documents without having to use HTML. With this comprehensive guide to both FrontPage 97 and ActiveX controls, readers can learn all about creating, publishing, and managing Web pages.

From creating the FrontPage 97 working environment, the book progresses to activating a Web site and working with texts, multimedia, links, tables and frames, forms, and templates and wizards. Enhancing the Web site with ActiveX controls and supporting Java, VBScript, and Netscape plug-ins are fully explained. Instruction is included on preparing, hosting, posting, and maintaining the Web site.

Designer's Guide to Flat-Panel Systems for the OEM and Industrial User

Computer Dynamics
7640 Pelham Road
Greenville, SC 29615
Tel: 864-627-8800
Fax: 864-675-0106
E-mail: sales@.cdynamics.com
Web: www.cdynamics.com
Free



CIRCLE 347 ON FREE INFORMATION CARD

The broadest range of OEM flat-panel display solutions is presented in this catalog: complete flat-panel computers, plug-in flat-panel CRT replacements, the latest displays (XGA, SVGA, and VGA resolutions, with sizes ranging from 6.4-inches to 17.7 inches), and an extensive touchscreen selection. Also included are product selection guides, design tips, and complete information on Computer Dynamics PC-compatible single-board computers.

BooksNow To order books in this magazine or, any book in print. Please call anytime day or night: **(800) BOOKS-NOW (266-5766)** or (702) 258-3338 ask for ext. 1456 or visit on the web at **http://www.BooksNow.com/electronicsnow.htm**.

Numerous custom configuration options are given for each of the 22 displays shown. The guide features Computer Dynamics' major float-panel displays: Display Pac, VAMP, and the FP-Kit, as well as the new Ultra-Brites. Also included in The Designer's Guide are new enclosures and mounting options for flat-panel display systems, information

AT $299.95, NO OTHER DESIGN WORKSTATION GIVES YOU SO MUCH FOR SO LITTLE.

PROTO BOARD BRAND

Large Breadboarding area holds 24 ICS ...2,500 tie points with Life Time Guarantee!

Available now assembled or in kit form

Triple Power Supply ... +5V fixed, plus two variable ± 1.3 to ± 15V DC with short circuit protection

Function Generator ...sine/square/triangle ...plus TTL

8 TTL Logic Probe Indicators

UL-CSA Approved

Audio Speaker

Two Digital Pulsers

Two BNC Connectors for oscilloscopes and counters

Remainder of trainer now has a 3 YEAR warranty

OVER $600 WORTH OF WORLD CLASS TEST EQUIPMENT FOR UNDER $300!

The PB-503 is a total design workstation. It has everything! **Instrumentation**, including a function generator with continuously variable sine/square/triangle wave forms—plus TTL pulses. **Breadboards** with 8 logic probe circuits.

And a **Triple Power Supply** with fixed 5VDC, plus two variable 1.3 outputs (+1.3 to 15VDC and –8 to 15VDC). Throw in 8 TTL compatible LED indicators, switches, pulsers, potentiometers, audio experimentation speaker...plus a lifetime guarantee on all breadboarding sockets! You have everything you need right there in front of you! PB-503—one super test station for under $300! Order yours today!!

Can't Wait! Call Toll-Free For More Information
1-800-572-1028
or the name of your local distributor
OR VISIT OUR WEB SITE AT: www.globalspecialties.com

GLOBAL SPECIALTIES
70 Fulton Terrace, New Haven, CT 06512
(203) 466-6103 • Fax: (203) 468-0060

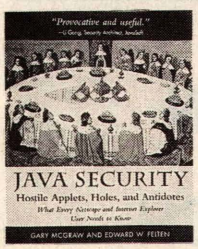
an Interplex Industries company

CIRCLE 122 ON FREE INFORMATION CARD

on software development tools for touch-screen implementation, and PC/104 expansion boards. All the flat-panel systems are accompanied by mechanical drawings.

Java Security: Hostile Applets, Holes, and Antidotes

by Gary McGraw and Edward W. Felten
John Wiley & Sons, Inc.
605 Third Avenue
New York, NY 10158
Tel: 212-850-6336
Web: http://www.wiley.com/compbooks
$19.95



CIRCLE 348 ON FREE INFORMATION CARD

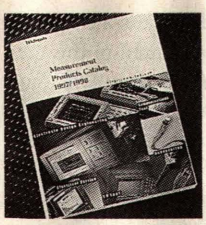
Do you know how to sort out fact from fiction when it comes to Java security? Did you know that whenever you surf the Web with Netscape or use Internet Explorer you are using Java? That means that someone else's code is running untested on your computer. Your site could be vulnerable to a hostile applet or other security problem.

Written by international security experts, this book tells you how Java security works and how it doesn't. Geared to webmasters or information-technology managers, it contains all the information needed to create a strategy for Java use. Included are guidelines for using Java more safely, the future of Java security, as well as explanations of the risks of using Java. The authors also explain the three prongs of the Java security model: Byte Code Verifier, Applet Class Loader, and the Security Manager; and discuss the holes in that model.

1997/1998 Measurement Products Catalog

Tektronix, Inc.
P.O. Box1520
Pittsfield, MA 01202
Tel: 800-426-2200 (Press 3, Code 1040)
Web: www.tek.com/Measurement
Free

Available worldwide, this publication is aimed at design engineers and professionals in the manufacturing, service, communications, and television testing fields. It includes a broad offering of


CIRCLE 349 ON FREE INFORMATION CARD

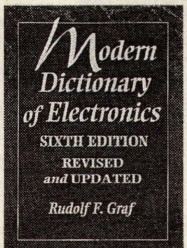
test equipment: instrumentation solutions range from low-cost instrumentation and handheld products to conventional measurement products and advanced mixed-signal test solutions.

Throughout, the catalog highlights products manufactured in the company's ISO-9001-certified facilities. In addition to its detailed product descriptions, the catalog lists Tektronix tutorials, and application and technical notes. Extensive indexes arrange products by name and by function, as well as by categories such as oscilloscopes, logic analyzers, VXI systems, telecommunications, and television test.

The 630-page, soft-cover catalog contains a full-color, new product section featuring 80 new products and measurement solutions. This is the first Tektronix catalog to use advanced computer-to-plate printing technology that provides much more detail in product photos than did previous versions.

Modern Dictionary of Electronics, 6th Edition

by Rudolf F. Graf
Newnes, Butterworth-Heinemann
225 Wildwood Avenue, Unit B
P.O. Box 4500
Woburn, MA 01801-2041
Tel: 617-928-2500
Fax: 617-933-6333
Web: www.bh.com/bh
$49.95



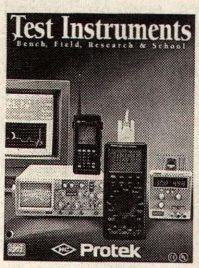
CIRCLE 350 ON FREE INFORMATION CARD

With over 25,000 electronics terms and hundreds of illustrations, this revised edition includes 5000 more definitions than were in the previous one. In addition, all the previously published terms were updated and revised, where necessary. Definitions are written in a clear and simple style, consistent with the complexity level of the term being defined.

The dictionary covers special topics, such as audio electronics, television and video, computers, fiber optics, microelectronics, communications, industrial processes, and medical electronics. Abbreviations and acronyms are given, and there are tables of SI units and schematic symbols.

Test Instruments Catalog

HC Protek, Inc.
154 Veterans Drive
Northvale, NJ 07647
Tel: 201-767-7242
Fax: 201-767-7343
E-mail: hcprotek@aol.com
Web: www.techexpo.com/www/hcprotek
Free



CIRCLE 351 ON FREE INFORMATION CARD

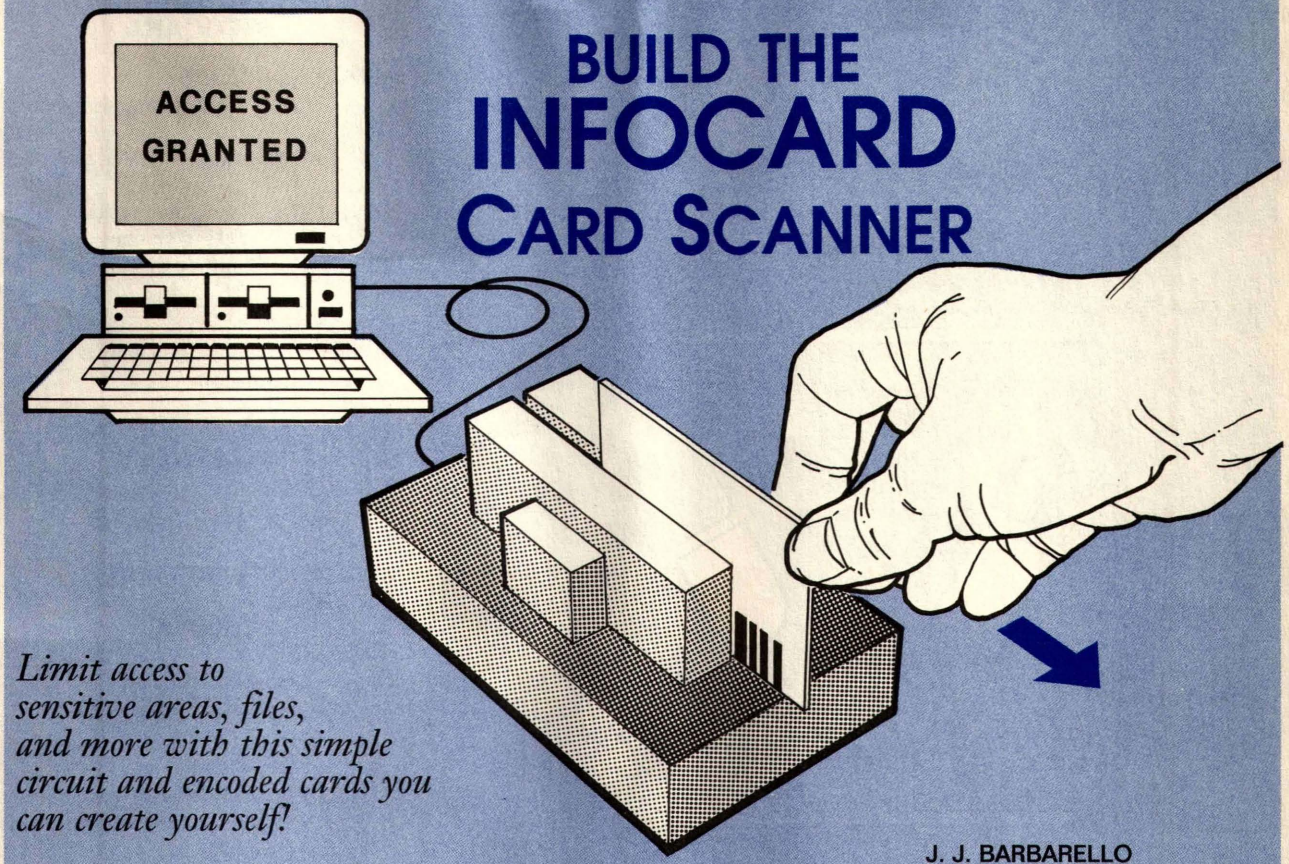
A series of newly developed test instruments—RF generators, AC millivolt meters, portable power supplies, digital multimeters, and analog meters—are among a number of cost-effective, high-reliability products featured here. Some of the new products highlighted in this edition are audio generators such as the B-850, the A800-series of VOMs, and a group of 30xx power supplies.

This 52-page publication details more than 75 instruments. It incorporates quick reference guides for selecting digital and analog products, including digital storage scopes, portable and bench-type scopes, state-of-the-art DMMs, and other instruments. The catalog also provides comprehensive specifications data for all products, along with cross-reference indexing for easy identification. Black and white photos accompany each product description. EN

BooksNow To order books in this magazine or, any book in print. Please call anytime day or night: **(800) BOOKS-NOW (266-5766)** or (702) 258-3338 ask for ext. 1456 or visit on the web at **http://www.BooksNow.com/electronicsnow.htm.**

AMERICAN HEART ASSOCIATION MEMORIALS & TRIBUTES
SM
1-800-AHA-USA1
American Heart Association

BUILD THE INFOCARD CARD SCANNER



Limit access to sensitive areas, files, and more with this simple circuit and encoded cards you can create yourself!

J. J. BARBARELLO

Reflective-optical sensors are non-contact devices that use a light source and a photo-sensitive detector to detect the presence or absence of a reflective surface. To sense that type of surface, the source and detector are positioned so the light hits the surface at an angle; the reflected light is then seen by the detector. Infrared (IR) sensors produce better results than visible light sensors because IR energy in the 900-nanometer range is not normally present in large amounts in visible light. An IR sensor can be used easily where ambient light might cause false triggering of a visible-light detector.

A "reflective surface" might lead you to think of a surface such as a mirror that's either present (reflective) or absent (non-reflective). However, while paper is a good reflector of infrared light, many different types of inks (and the graphite in a lead pencil) do *not* reflect IR energy very much. With the right type of ink, we can use a reflective IR optical sensor to make a device that reads a series of different width bars separated from each other by a white space on a card. One such bar pattern is the Universal Product Code, or UPC—otherwise known as "bar" codes. However, such a code is not limited to the UPC standard. For example, we can use a basic binary code instead. A system with simple wide and narrow bars to code the ones and zeros in a binary code results in a bar code that is easy to sense and can have up to 32,767 possibilities with only 15 bars.

The InfoCard project presented here uses a low-cost reflective-IR optical sensor and a simple interface circuit to create an electronic identification system using any PC. One such use of the InfoCard is for coded-entry access by reading a card and energizing an electric door latch for authorized codes. If you are good at programming PIC chips or Basic Stamp devices, you can readily adapt the InfoCard's Basic software routines to use the reader as a stand-alone device.

The swipe cards themselves can be made quickly and cheaply from almost any available paper stock. Best of all, the project cost is about $10–$15, depending on the parts you might already have on hand.

Design Considerations. To find out how far a reflective surface has to be from the sensor in order to see the most reflected light, we can use the law of optics that says that when light hits a surface at an angle, the angle at which it hits the surface (the *angle of incidence*) is equal to the angle at which it is reflected (the *angle of reflection*). That is shown in Fig. 1A.

As you can see, the reflecting surface is at the perfect distance from the light source and sensor to pick up the greatest amount of reflected light. If the surface is closer or farther away, the amount of energy that the sensor can detect

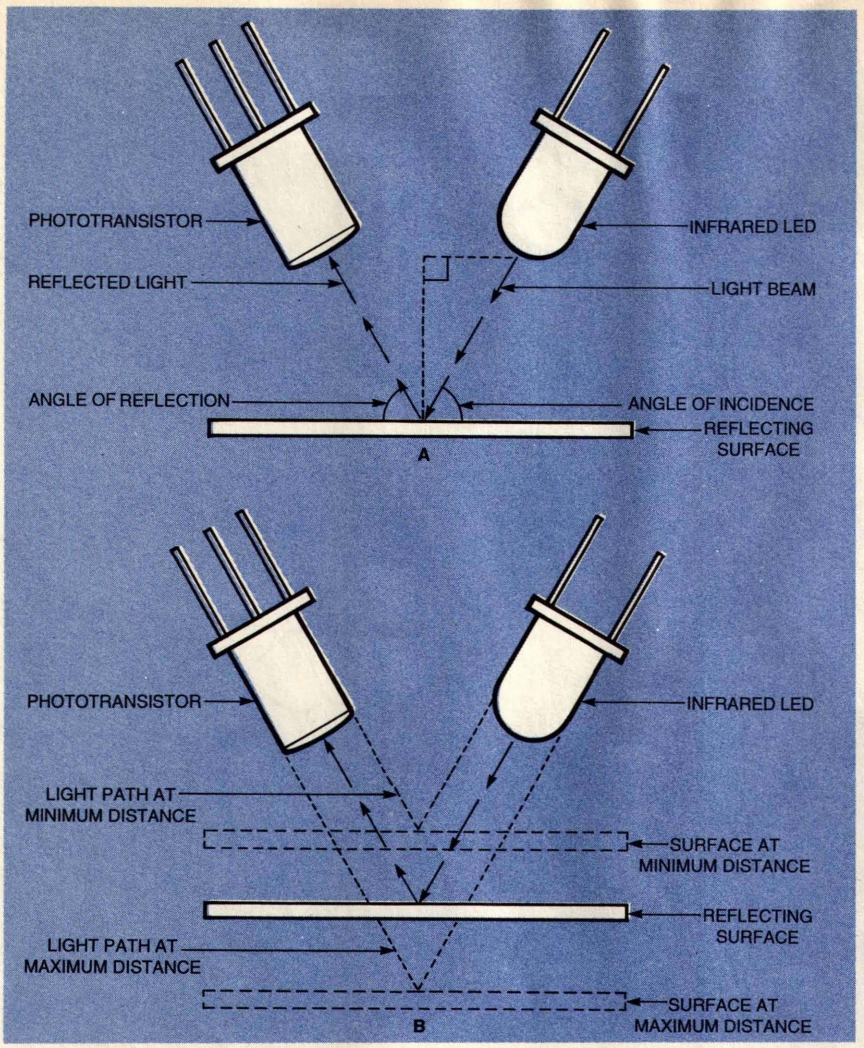


Fig. 1. If a light beam strikes a reflective surface at an angle, it will bounce off at a "mirror-image" angle (A). For best sensing, the surface must be within the area that the light source and detector are focused on (B). If the surface is too close or too far away, the light will not hit the detector.

PARTS LIST FOR THE INFOCARD

SEMICONDUCTORS

IC1—78L05 5-volt regulator, low-power, integrated circuit
IC2—LM339 quad comparator, integrated circuit
SEN1–1STS708 reflective optical switch (Jameco 138093 or similar)
LED1—Light-emitting diode, red

RESISTORS

(All units are ¼-watt, 5% units unless otherwise noted.)
R1, R5—220-ohm
R2, R8—22,000-ohm
R3, R4, R6, R9—2200-ohm
R7—10,000-ohm potentiometer, multi-turn

ADDITIONAL PARTS AND MATERIALS

C1, C2—1µF, 16-WVDC, electrolytic capacitor
J1—DB25 connector, male
9-volt battery, battery connector, hardware, etc.

NOTE: Enhanced software, part number ICARD-S (both source and executable code) is available for $12.00 from: James J. Barbarello, 817 Tennent Road, Manalapan, NJ 07726. In addition, the author will be happy to answer any questions sent to the adress above (please include a self-addressed, stamped envelope).

will drop off. That is shown in Fig. 1B. If the reflecting surface is too close or too far, the reflected light will miss the sensor completely. Based on the specifications of the reflective sensor we want to use, we can apply simple trigonometry formulas to find the perfect distance from the sensor to the reflective surface. For the device called for, that distance works out to about $^5/_{32}$ inch.

But we shouldn't stop at just the optimum distance; we should also find the minimum and maximum distances. Again, using basic trigonometry, we find that the surface should not vary more than $^1/_{32}$ inch in either direction from the $^5/_{32}$-inch distance. With those numbers, the card guide that we design should keep the card between $^1/_8$ inch and $^3/_{16}$ inch from the sensor.

One more piece of information to keep in mind when working with light has to do with the tendency of light to disperse from its source. An example of that can be seen in Fig 2A. The width of the beam will affect how narrow a barcode stripe can be seen. By adding an aperture as shown in Fig. 2B, the resolution improves. The width of the aperture must be large enough to allow enough light to be reflected back, but small enough to obtain the desired resolution. The InfoCard will be using a $^1/_{16}$-inch-wide aperture. That will let us space the bars on the card $^1/_{16}$ inch apart.

Circuit Description. As you can see in the schematic diagram shown in Fig. 3, the interface circuit for the InfoCard is quite simple and straightforward. Reflective IR sensor SEN1 contains a matched IR diode and an IR detector in a single case. The current for the IR diode is limited by R1; R2 is a pull-up resistor for the collector of the detector. That lets a proper voltage level always be present at the positive input of IC2-b. The negative input is connected to an adjustable voltage divider made up of R3, R7, and R8. By varying R7, the voltage level at which the comparator switches can be set.

When the positive input of IC2-b is less than the negative input, the output will be grounded. That occurs when a reflecting surface is close enough to SEN1 to reflect IR light onto the detector. Otherwise, the output will have no voltage on it. The LM339 was designed that way so that the output could be used in circuits that needed the output level to be different than the supply voltage. Because of that, R4 is used to pull up the output of IC2-b when the output should be high. That signal is connected to pin 11 of the PC's printer port.

A second comparator in IC2 is used as an LED driver. When pin 2 of

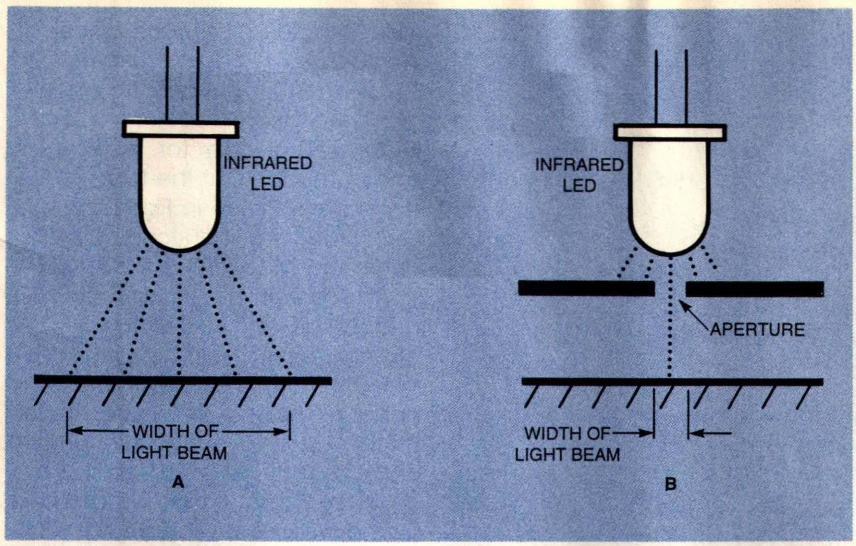


Fig. 2. Even laser light spreads out as it leaves the source (A). That spreading is called divergence. *If the spreading light is blocked by an aperture (B), the light beam will have a greater pinpoint accuracy.*

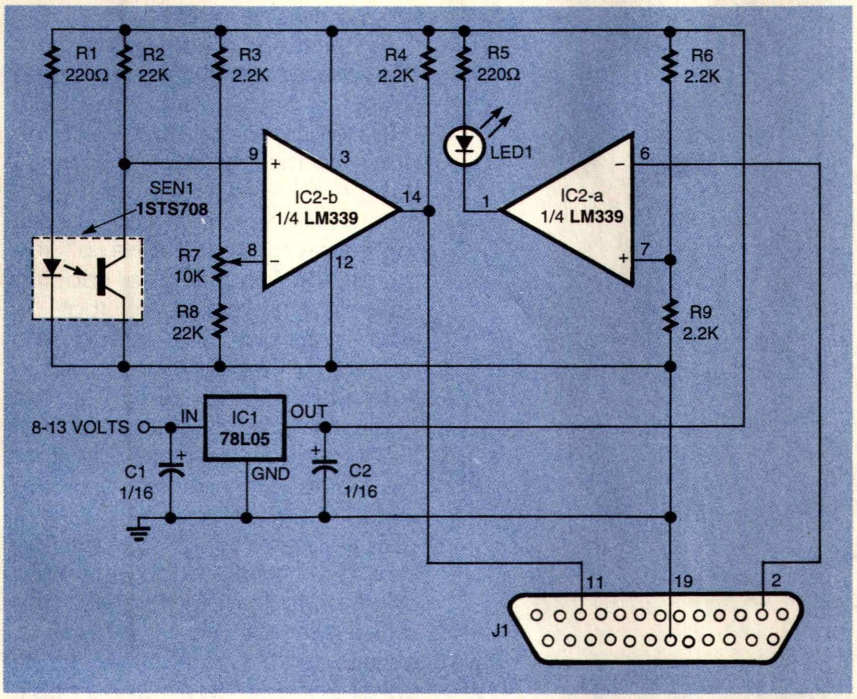


Fig. 3. The InfoCard's circuit is built around a reflective optical sensor (SEN1) and a comparator (IC1).

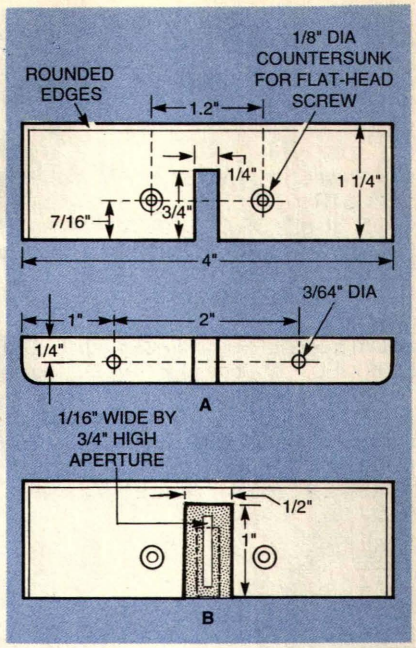


Fig. 4. The card guides need a slot in one of them to mount the sensor. Use flat-head screws to mount the sensor so that the guide slot will be smooth.

the parallel port is brought high, IC2-a's output will be open, turning off LED1. A low input to IC2-a will ground its output, letting current flow through R5 and LED1, turning it on. Voltage-divider string R6 and R9 set a switching level for IC2-a that is compatible with the voltage levels present on the parallel port.

Power from any suitable voltage source between 8 and 13 volts is regulated to 5 volts by IC1, with C1 and C2 providing filtering.

Construction. The construction details presented here are only for purposes of building an InfoCard demonstrator. Once you are familiar with the design and operation of the unit, no doubt you'll be designing your own custom housings and installations. To begin, we'll start with the card guides.

The dimensions of the card guides are shown in Fig. 4. Use two pieces of ½-inch-thick wood or metal with the dimensions shown in Fig 4A. Both pieces should have their edges rounded as shown. Keep in mind, however, that the rounding shown is greatly exaggerated. It is important that the edges be smooth so that a swipe card will not hang up or tear as it is slid through the guide. The edges that will be rounded will be facing each other to form the guide.

Both guides will have holes drilled in their bottom edge as shown. If you are using metal for the guides, you will have to tap threads into the holes. Once that is done, set one piece aside—it is finished. The second piece will have a notch cut in it as shown for SEN1. The countersunk holes will be used to mount SEN1; the countersink goes on the inside of the guide. The holes should be sized to fit a 4-40 flathead screw.

Install a pair of flathead screws in the countersunk holes with nuts. A second pair of nuts should then be threaded onto the protruding screw threads. Take a piece of perfboard that is large enough to mount SEN1 and drill two holes to match the spacing of the flathead screws. Mount SEN1 on the perfboard. That assembly is then mounted on the screws and held in place with an additional pair of nuts. The second and third nuts will form a "sandwich" that will hold SEN1 in position. Adjust the position of the nuts so that the front of SEN1 is perpendicular to the

LISTING 1

```
REM** INFOCARD.BAS
REM** V970719
REM**
CLS : DIM n(14)
x$ = "##### " + STRING$(4, 196) + CHR$(62) + CHR$(32) + CHR$(179)
sp$ = STRING$(10, 32)
OPEN "scrn:" FOR OUTPUT AS #1
LOCATE 1, 27: PRINT "PcInfoCard Card Generator"
LOCATE 2, 1: PRINT STRING$(80, 220);
'PROGRAM BEGINS
getnumber:
LOCATE 5, 27: PRINT SPACE$(50): LOCATE 5, 27
LINE INPUT "ID Code (0 to 32767): "; number$
 IF LEN(number$) = 0 THEN number$ = "0"
 IF VAL(number$) < 0 OR VAL(number$) > 32767 THEN BEEP: GOTO getnumber
number = VAL(number$): n = number: code$ = ""
FOR i = 14 TO 0 STEP -1
 IF n >= 2 ^ i THEN
 n(i) = 1
 n = n - 2 ^ i
 ELSE
 n(i) = 0
 END IF
NEXT i
FOR i = 14 TO 0 STEP -1
 IF n(i) = 1 THEN
 code$ = code$ + CHR$(219) + CHR$(221)
 ELSE
 code$ = code$ + CHR$(221)
 END IF
NEXT i
code$ = code$ + CHR$(222)
code = LEN(code$): delta = 34 - code
IF delta / 2 <> INT(delta / 2) THEN
 d1 = INT(delta / 2): d2 = INT(delta / 2) + 1
ELSE
 d1 = delta / 2: d2 = d1
END IF
LOCATE 7, 1
CLOSE : OPEN "scrn:" FOR OUTPUT AS #1: GOSUB card
LOCATE 5, 27: PRINT SPACE$(50)
LOCATE 8, 52: PRINT "Press"
LOCATE 9, 52: PRINT "-----"
LOCATE 11, 52: PRINT "<H> for Hardcopy"
LOCATE 13, 52: PRINT "<Esc> to End"
LOCATE 15, 52: PRINT "Any Other Key to Try Again"
getoption:
a$ = INKEY$: IF a$ = "" THEN GOTO getoption
a$ = UCASE$(a$)
SELECT CASE a$
 CASE IS = CHR$(27)
 CLS : LOCATE 18, 1: END
 CASE IS = "H"
 CLOSE : OPEN "lpt1:" FOR OUTPUT AS #1: GOSUB card
END SELECT
FOR i = 8 TO 15
 LOCATE i, 52: PRINT SPACE$(26)
NEXT i
GOTO getnumber
'
'SUBROUTINE TO PRINT/DISPLAY CARD
card:
PRINT #1, sp$; CHR$(218); STRING$(code + delta, 196); CHR$(191)
FOR i = 1 TO 7
 PRINT #1, sp$; CHR$(179); STRING$(code + delta, 32); CHR$(179)
NEXT i
PRINT #1, sp$; CHR$(179); STRING$(22, 32);
PRINT #1, USING x$; number
FOR i = 1 TO 3:
 PRINT #1, sp$; CHR$(179); STRING$(d1, 32); code$; STRING$(d2, 32); CHR$(179)
NEXT i
PRINT #1, sp$; CHR$(192); STRING$(code + delta, 196); CHR$(217)
RETURN
```

surface of the guide and about 1/8 inch below the guide's surface.

An aperture is made from some black electrical tape or a black write-protect tab for a 5¼-inch computer disk. Cut the tape to the dimensions shown in Fig. 4B. A 1/16-inch wide by ¾-inch long slit is also cut in the tape. Place it over SEN1 so that the slit lines up with the LED and the detector in SEN1.

A base plate is made from 1/8-inch hardboard or metal as shown in Fig. 5. The four elongated holes will be used to mount the guides and adjust the width of the slot. The 1/8-inch diameter hole will be used for the wires that will connect SEN1 to the circuit board. If you wish to use a rubber grommet, you should size the hole as needed.

Mount the two card guides onto the base with their rounded edges facing towards each other. Use appropriate screws to mount the guides to the base (wood screws if the guides are made of wood; machine screws if metal). Loosen the screws holding one of the guides and adjust the spacing between the guides so that an index card can pass through the opening with ease, but not move from side to side. Re-tighten the guide in place and check the fit of the index card to make sure that the guide did not shift or move while tightening it down.

The interface circuit for the InfoCard is simple enough to build on a perfboard by following the schematic diagram in Fig. 3. Component placement is not critical. In place of SEN1, make a cable from three equal lengths of insulated wire that will be able to reach from the board to SEN1. Make note of which wires will be connected to the various pins on SEN1.

A second three-wire cable will be used to connect the InfoCard to the PC. Again, three equal lengths of 22- or 24-gauge stranded wire are used. Connect them to pins 2, 11, and 19 of a 25-pin connector. The other ends of the wires connected to pins 2, 11, and 19 are connected to the circuit according to Fig. 3.

Thread the three-wire cable for SEN1 through the hole in the base plate and connect the wires to SEN1. If you are not sure which

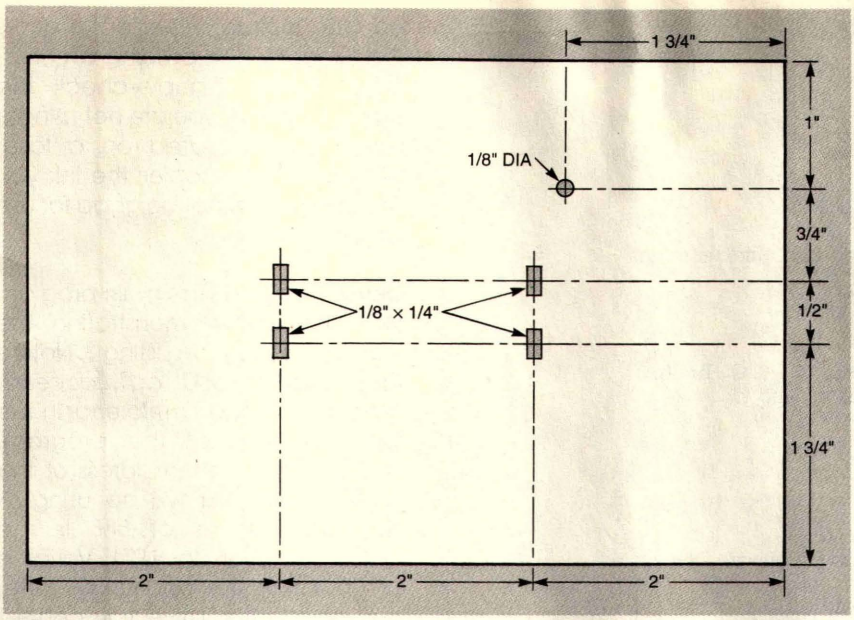


Fig. 5. The base plate has elongated slots so that the width of the card guide can be adjusted. The wires from the sensor pass through the hole in the upper corner. If you are going to use metal for the base plate, make that hole a bit larger and use a rubber grommet to protect the wires.

LISTING 2

```
'** ICARDTST.BAS
'** Version 970715.1
CLS : DEF SEG = 64: ad0 = 888: ad1 = 889
OUT ad0, 2
PLAY "l64t240"
LOCATE 1, 1
COLOR 0, 7: FOR I = 1 TO 3: PRINT SPACE$(80); : NEXT i
LOCATE 2, 22
PRINT "PcInfoCard Test (Press <Esc> to End)"; : COLOR 7, 0
LOCATE 10, 25: PRINT "Emitter "; STRING$(3, 219); ") \"
LOCATE 11, 40: PRINT "\"
LOCATE 12, 42: PRINT "\"
LOCATE 15, 24: PRINT "Detector "; STRING$(3, 219); ")"
loop00:
a = INP(ad1) AND 128
 IF a = 0 THEN
 OUT ad0, (INP(ad0) AND 254)
 FOR i = 10 TO 15: LOCATE i, 43: PRINT CHR$(32): NEXT i
 LOCATE 13, 41: PRINT " "
 LOCATE 14, 39: PRINT " "
 PLAY "n48l64p4"
 ELSE OUT ad0, (INP(ad0) OR 1)
 FOR i = 10 TO 15: LOCATE i, 43: PRINT CHR$(222): NEXT i
 LOCATE 13, 41: PRINT "/"
 LOCATE 14, 39: PRINT "/"
END IF
a$ = INKEY$: IF a$ = "" THEN GOTO loop00
IF ASC(a$) <> 27 THEN GOTO loop00
END
```

leads are for the LED, measure the resistance across the leads with an ohmmeter. If the ohmmeter shows conduction in one direction, those pins are the LED; if neither direction conducts, they are the detector. Checking the LED with an ohmmeter will also show its polarity.

If you want, you can mount the circuit board to the bottom of the base plate. A set of long screws or standoffs can be used as legs, if desired.

Making a Swipe Card. The coded card consists of narrow (to represent a "0") and wide (for a "1") bars separated by blank white spaces. The wide bar must be at least twice as wide as the narrow bar, and the blank must be as wide, if not wider, than the aperture. The bars should be positioned on the card so their bottoms are within $^1/_8$ inch of the card's bottom. Finally, the bars should be at least ½-inch high.

The bars are read right-to-left when looking at the card with the bars at the bottom. The first bar is always narrow—it is a reference bar and is not part of the binary code. The next fifteen bars are a binary representation of a number between 0 and 32767. The first bar after the reference bar is bit 0, with each bit proceeding in order from there up to bit 14.

Making a swipe card is easy with the program in Listing 1. When you enter a number between 0 and 32767, the resulting barcode is displayed on the screen. To print that pattern on a card, press "H". Once printed, cut away the excess paper so that the card will be the correct size. The program marks where the edges of the card should be as a guide.

Some printer inks are not IR absorbing (such as the ink used in Hewlett Packard ink jet printers). The best results are obtained with a laser printer or by photocopying a card that has been printed. If you don't have access to a laser printer or a photocopier, you can fill in the bars with a felt-tipped pen that has IR-absorbing ink. You can use the InfoCard's testing and calibration program in the next section to find out if the particular felt-tipped pen you plan to use will do the job.

Testing and Calibration. Apply power to the InfoCard, connect it to a PC's printer port, and load the QBASIC program in Listing 2. Using a DC voltmeter, adjust R7 until the voltage on pin 8 of IC2 is about 4 volts.

Place a card in the card guide so that a wide bar is directly in front of the aperture. Check to see if LED1 is lit. If it is not, turn R7 to increase the voltage level on pin 8 of IC2 until LED1 comes on. Start turning R7 the other way slowly until LED 1 goes out, then add an additional ¼ turn. If the swipe card is moved so that SEN1 sees the white of the card, LED1 sould turn back on.

If that procedure does not work as it should, check the accuracy of the circuit wiring, make sure that all components are properly orientat-

LISTING 3

```
REM ** ICARD.BAS
REM ** Version 970720
REM
CLS : DEF SEG = 64: ON ERROR GOTO errorloop
DEFINT A-B, X: DIM a(25), b(25)
ad0 = 888: ad1 = 889
access1 = 226: 'If this code found, Relay will activate.
timerelayon = 10: 'Time Relay Stays On.
timeforerror = 5: 'Time to wait when an error occurs before resetting.
'
'**PROGRAM BEGINS
'
loop01:
CLS : LOCATE 10, 36: PRINT "Ready..."; : x = 0: xo = 0: OUT ad0, 3
WHILE (INP(ad1) AND 128) = 0: WEND: 'Wait for Card
'** Card In. Turn Off LED and Wait for Bars.
OUT ad0, 2
WHILE (INP(ad1) AND 128) = 128: WEND
'** First Bar Found.
redo1:
WHILE (INP(ad1) AND 128) = 0: x = x + 1: WEND
IF (x - xo) < 10 THEN x0 = x: x = 0: GOTO redo1: 'Software DeBounce
a(0) = x: b(0) = 0
'** Width of first (reference) line measured as a(0)
FOR i = 1 TO 15
redo01:
x = 0
'Wait for next line.
WHILE (INP(ad1) AND 128) = 128: WEND
'Determine Width of Line.
WHILE (INP(ad1) AND 128) = 0: x = x + 1: WEND
IF x < .1 * a(0) THEN GOTO redo01: ' Software Debounce
a(i) = x
NEXT i
'** Card Read Done. Ref is a(0). Bits are a(1)-a(15).
loop02:
CLS : code = 0
FOR i = 1 TO 15: b(i) = 0
SELECT CASE b(i - 1)
 CASE IS = 0
 IF a(i) > a(i - 1) * 1.5 THEN b(i) = 1: code = code + 2 ^ (i - 1)
 CASE IS = 1
 IF a(i) > a(i - 1) * .75 THEN b(i) = 1: code = code + 2 ^ (i - 1)
END SELECT
NEXT i
LOCATE 10, 30: PRINT "CODE: "; code
LOCATE 11, 27: PRINT "(";
 FOR i = 1 TO 15: PRINT RIGHT$(STR$(b(i)), 1); : NEXT i: PRINT ")"
LOCATE 18, 20: PRINT "<Esc> Ends, Any Other Key Continues...";
blink01:
IF code = access1 THEN blink1 = 0: blink2 = 1 ELSE blink1 = 2: blink2 = 3
 OUT ad0, blink1
start1! = TIMER
 WHILE (TIMER - start1!) < timerelayon
 OUT ad0, blink1
 start! = TIMER
 WHILE (TIMER - start!) < .15: WEND
 OUT ad0, blink2
 start! = TIMER
 WHILE (TIMER - start!) < .15: WEND
 a$ = INKEY$
 IF a$ <> "" THEN
 IF ASC(a$) = 27 THEN OUT ad0, 2: END ELSE GOTO loop01
 END IF
 WEND
GOTO loop01
errorloop:
LOCATE 10, 15
BEEP: PRINT "Error Reading Card. <Esc> to End, or Wait For Reset.";
start! = TIMER
WHILE (TIMER - start!) < timeforerror
 a$ = INKEY$: IF a$ <> "" THEN a = ASC(a$) ELSE a = 0
 IF a = 27 THEN OUT ad0, 2: END
WEND
RESUME loop01
```

ed, and look for other basic errors that occur when building an electronic circuit. Double-check the wiring to SEN1. If you are not using a swipe card created on a laser printer or photocopier, the ink you are using might not be good for use with the InfoCard.

Using InfoCard. The main program for using and demonstrating the InfoCard is shown in Listing 3. Notice the variables *ad0, ad1, access1, timerelayon,* and *timeforerror* in the first few lines of the program. Variable *ad0* is the address of the parallel port you will be using. A decimal address of 888 is the default location for LPT1. Variable *ad1* points to the location just after *ad0*. As an alternative, you can set *ad1* to equal *ad0* + 1. That way, if you change the port that you're using, *ad1* will automatically track which port you are using. Variable *access1* is the card code that will activate LED1. Variables *timerelayon* and *timeforerror* set the time duration, respectively, of how long LED1 will remain on and how long the program will wait before resetting itself if an error occurs. You can change each of those variables to suit your needs.

With the program running and the InfoCard hardware connected and powered up, the screen will simply say "Ready". Run a card through the reader. The card's value will be displayed. If the value matches the value in *access1*, LED1 will light. Pressing the Escape key will end the program, while pressing any other key or waiting for the time specified by *timerelayon* will reset the program to the "Ready" mode. If the card doesn't read properly, the screen will display "Error in Reading Card". You can either press the escape key to end the program or wait for the program to reset itself to the "Ready" mode. In that case, the delay time before reset is controlled by the *timeforerror* variable.

Relays and Other Options. Replacing LED1 with an optoisolator will let you interface the InfoCard with other hardware that can be controlled by an on-off-style switch. Devices such as the MOC3010

(Continued on page 49)

BUILD A DIGITAL-STORAGE OSCILLOSCOPE FOR YOUR HIGH-PERFORMANCE LOGIC ANALYZER

Combine this add-on device, March's Logic Analyzer, and almost any PC, and get a full-featured digital-storage oscilloscope.

ROBERT G. BROWN

Everyone who works with electronics would like to have a decent oscilloscope as a part of their bench equipment. Unfortunately, top-end oscilloscopes command top-end prices, putting them out of reach of some hobbyists. No doubt you've studied the article "Build a High-Performance Logic Analyzer" that was featured in the March 1998 issue of **Electronics Now**. That device sported an expansion port to which you could attach additional add-on modules.

As promised, this month we are presenting such an add-on module. With this module, you can turn the High-Performance Logic Analyzer into a 40-million-samples-per-second dual-trace digital-storage oscilloscope. Like the Logic Analyzer, the digital-storage oscilloscope, or DSO, connects to any PC and only requires DOS to run the host software with a CGA or greater display. Those computer requirements mean that you can easily recycle that old PC that can't run any modern software, but is still too good to just get rid of.

The unit itself can sample two analog channels and four digital inputs simultaneously. The sampling rate can be chosen from any of 10 built-in rates ranging from 40 MHz down to 312.5 kHz. If those rates don't fit your needs, you can use either of the logic analyzer's two external clock inputs. The oscilloscope features include the ability to use standard 10X scope probes, three trigger modes including a sweep-triggered mode with settable level and slope, plus triggering of the storage cycle with the digital-logic inputs.

Like the logic analyzer that it works with, the DSO can store up to 2048 samples. Additional advantages of a computer-based DSO include the ability to capture and view a transient signal, both before and after the trigger event, and the ability to save the captured data to disk for printing and later study.

Designing a DSO. The functions of a logic analyzer and digital-storage oscilloscope are in many ways very similar. In a DSO, digitized analog signals are stored for later display, much like a logic analyzer, which stores digital signals for later display.

To take advantage of that fact, the companion logic analyzer was designed to hold all of the functions that are common to both devices. That way, the DSO module is simply an analog front-end for the logic analyzer. The main advantage to that approach is that it helps keep the cost of the project down. The result is having two very powerful test instruments, a logic analyzer and a digital-storage oscilloscope, for about the same cost as a digital-storage oscilloscope alone.

Circuit Description. The schematic diagram for the DSO is shown in Fig. 1. The two analog channels are identical, so only one channel will be described; the other channel works the same way. The input signal is buffered by IC1-a, a high-speed FET-input op-amp. There is no gain in that first stage as its only function is to prevent loading the source of the input signal—which is why the op-amp has a FET-based input. The actual input impedance is set by R1 and the scope-probe resistance (usually 9 megohms for a 10X probe).

The buffered signal is then fed into high-speed op-amp IC2-a, which is configured as an inverting amplifier. The amplifier's gain can be varied with R7. An offset voltage is also added so that the amplifier signal will be within the proper voltage range needed for digital conversion. The offset voltage source comes from IC4, the analog-to-digital converter. The reference voltage is buffered by IC3-b, and then inverted by IC3-a. The amount of offset can be varied with R13 in order to adjust the DSO's ground reference voltage.

The final output signal is then fed through R16 into IC4. A Zener diode, D1, protects the input of IC4 from excessive input voltages. That chip, a dual high-speed six-bit analog-to-digital converter, is the heart of the DSO. The rate at which the DSO takes samples is controlled by the logic analyzer through a clock signal on pin 24 of J2. Both scope channels are digitized at the same time with each clock pulse. The sample rates of the DSO are therefore the same as the rates available from the logic analyzer. The six-bit digitized signals convert the analog signal into one of 64 levels. The digital data is buffered by IC5 and IC6. The signals are passed to the logic analyzer through J1. A series of 33-ohm resistors (R20 through R33) provide termination for the data signals.

Since the DSO produces six bits per channel for a total of 12 bits and the logic analyzer has a total capacity of 16 channels, four bits are unused. Those four bits are made available as additional digital channels on the DSO as TP4–TP7. The digital channels connected to TP4 and TP5 can be used as an external trigger on a given logic condition instead of the standard triggered sweep.

There are three test points on the board that are used for probe calibration. They can also be very handy for testing the DSO and troubleshooting the unit. A steady logic low and high are available at TP2 and TP3, respectively. A 312.5-kHz squarewave signal from the logic analyzer (via pin 26 of J2) is available on TP1 as a calibration signal.

Because IC4 is a mixed-signal device—a combination of analog and digital circuits—multiple power

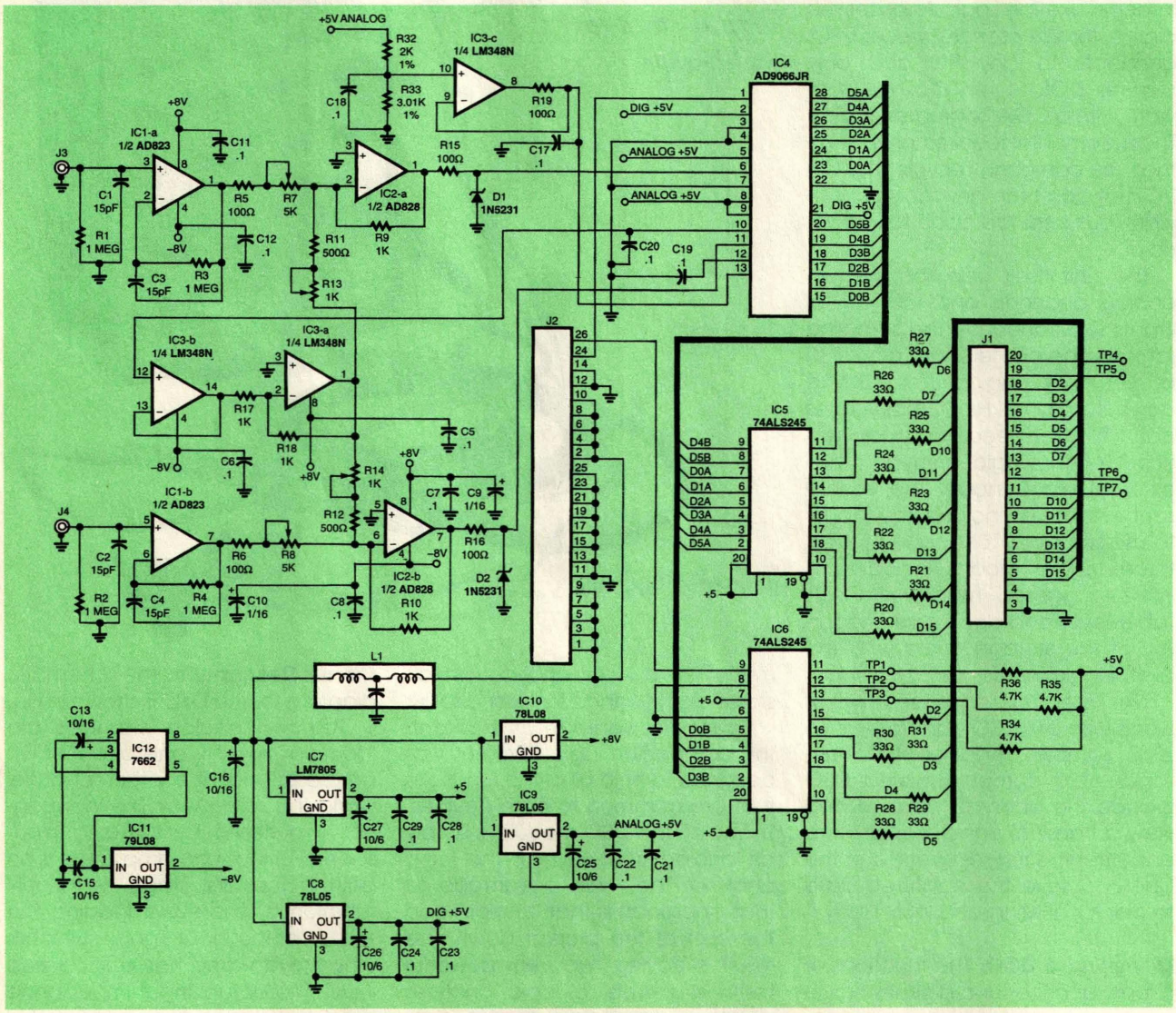


Fig. 1. The Digital-Storage Oscilloscope is an add-on module for the High-Performance Logic Analyzer. It is built around a two-channel, 6-bit analog-to-digital converter. Four additional digital-logic channels are included as a bonus.

and ground pins are used to improve performance. Separate supply-voltage regulators are used to minimize any noise that might be present.

To further improve the noise immunity and response of the DSO, external reference voltages are used for IC4 instead of the chip's internal references. The high-end reference has been raised to 5 volts available from IC9, while the low-end reference has been set to 3 volts by R32, R33, and IC3-c.

Power for the DSO module is supplied from the logic analyzer through J2 and L1, a 3-pin EMI filter that removes digital noise from the power line. The filtered 12-volt power feeds the various positive-voltage regulators in addition to IC12, a 7662 voltage inverter. That inverter creates a negative voltage, which is regulated to -8 volts by IC11.

Building the Digital-Storage-Oscilloscope Module. Construction of the DSO is very similar to, if not exactly like, the companion logic analyzer. Reviewing the construction section of that article is a good idea before beginning. You should also get a copy of the DSO software either from the Alta Engineering Web site (http://www.gutbang.com/alta) or from the Gernsback FTP site (ftp://ftp.gernsback.com/pub/EN/altadso.zip). As an alternative, you can get the software from the source given in the Parts List. Like the logic analyzer, the DSO software doubles as a demo, letting you see what the DSO can do before actually building the module. Any last-minute suggestions or details that do not make it into print will be included with the software. You will need to unzip the file using PKUNZIP or another unzip program. The DSO module connects to the High-Performance Logic Analyzer, so you will need to have built and tested that unit as well.

Like the logic analyzer, the DSO module should only be built on a double-sided PC board with plated-through holes. The layout of the components and traces are very critical to proper operation, so no other construction method is likely to work. You can make your own PC board from the foil patterns included here, or one can be purchased from the source given in the Parts List.

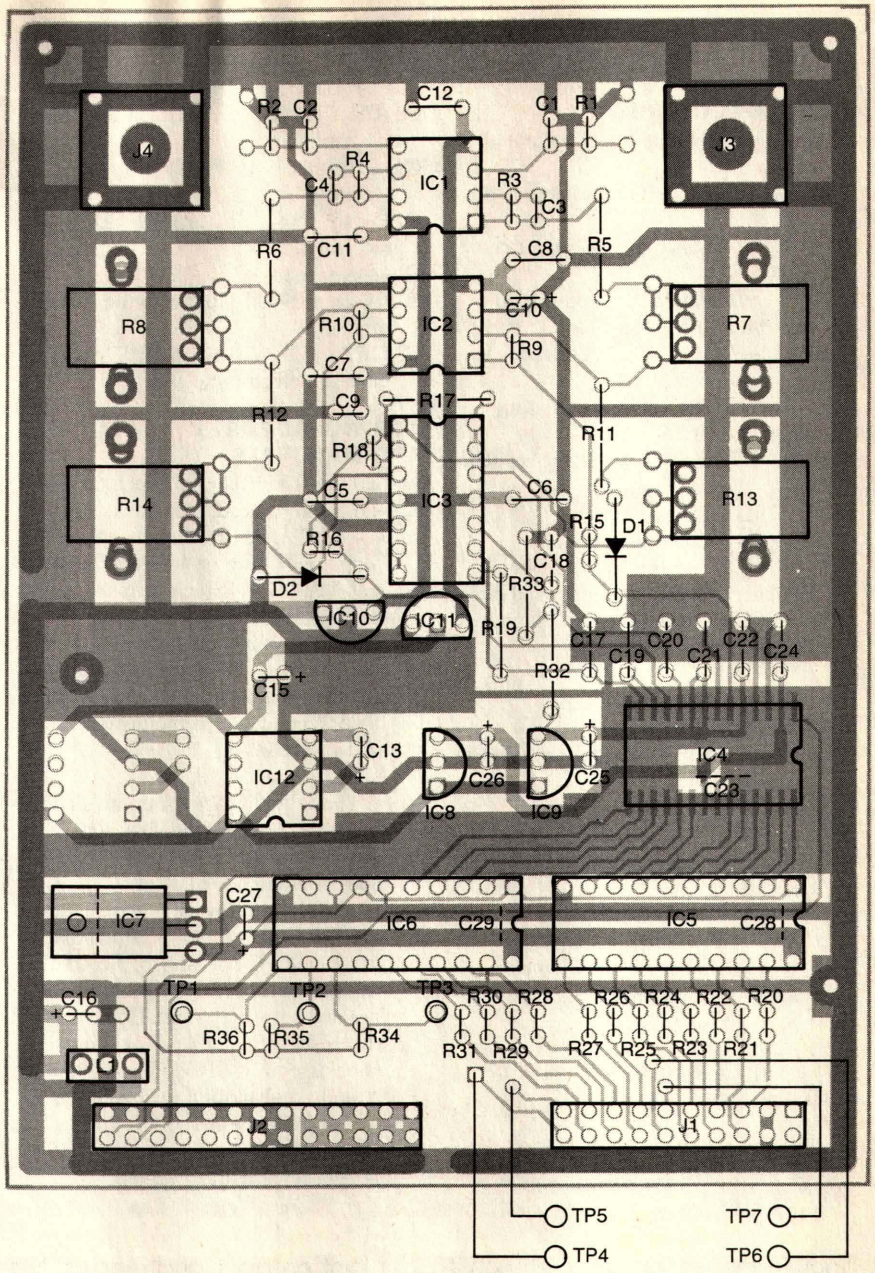


Fig. 2. Here is the parts-placement diagram for the DSO. Note that IC7 is mounted "upside down" from the normally-expected position—the metal tab will be pointing away from the board. Three surface-mount capacitors are soldered to the bottom side of the board.

Since IC4 is a fine-pitch surface-mount device, a low-wattage fine-tipped soldering iron should be used. The solder should be the smallest diameter that can be found—$^1/_{32}$-inch or less will work well. With a purchased board or one made from the foil patterns, we can begin construction by following the parts-placement diagram shown in Fig. 2.

Start by soldering C23, C28, and C29 to the bottom side of the board. A good technique is to first coat one of the pads with some solder. Place the capacitor on the board and hold it in place with a small screwdriver. Touch the same pad lightly with the soldering iron to re-flow the solder and tack the capacitor in place. Use a magnifying glass to carefully check the position of the capacitor to be sure that it is properly seated on the pads. Fix any alignment errors before continuing. When the part is properly aligned, solder the other end in place, being sure to create a well-coated solder joint. Once that joint is allowed to cool down, go

PARTS LIST FOR THE DIGITAL STORAGE OSCILLOSCOPE MODULE

SEMICONDUCTORS

IC1—AD823 dual op-amp, integrated circuit
IC2—AD828 dual op-amp, integrated circuit
IC3—LM348 quad op-amp, integrated circuit
IC4—AD9066JR dual analog-digital converter, integrated circuit
IC5, IC6—74ALS245 octal transceiver, integrated circuit
IC7—7805 5-volt voltage regulator, integrated circuit
IC8, IC9—78L05 5-volt voltage regulator, low-power, integrated circuit
IC10—78L08 8-volt voltage regulator, low-power, integrated circuit
IC11—79L08 8-volt negative-voltage regulator, low-power, integrated circuit
IC12—7662 voltage inverter, integrated circuit
D1, D2—1N5231 Zener diode

RESISTORS

(All resistors are ¼-watt, 5% units unless otherwise noted.)
R1–R4—1-megohm
R5, R6, R15, R16, R19—100-ohm
R7, R8—5000-ohm, potentiometer, printed-circuit mount
R9, R10, R17, R18—1000-ohm
R11, R12—500-ohm
R13, R14—1000-ohm potentiometer, printed-circuit mount
R20–R31—33-ohm
R32—2000-ohm, 1%
R33—3010-ohm, 1%
R34–R36—4700-ohm

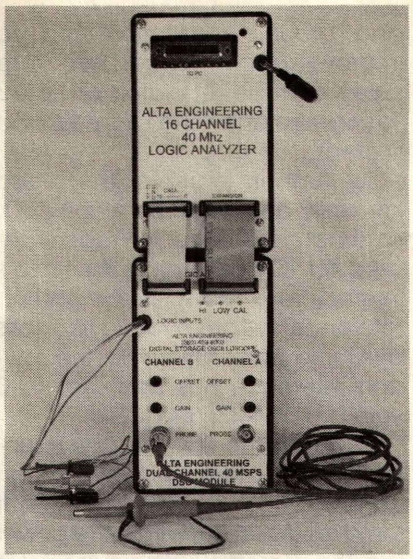
CAPACITORS

C1–C4—15-pF, ceramic disc
C5–C8, C11, C12, C17–C22, C24—0.1-µF, ceramic disc
C9, C10—1-µF, 16-WVDC, tantalum electrolytic
C13, C15, C16—10-µF, 16-WVDC, electrolytic
C14—Not used
C23, C28, C29—0.1-µF, ceramic, surface-mount
C25, C26, C27—10-µF, 6-WVDC, tantalum electrolytic

ADDITIONAL PARTS AND MATERIALS

J1—20 pin IDC header .51-inch tail
J2—26 pin IDC header .51-inch tail
J3, J4—BNC jacks, PC mount
L1—Input RFI filter or 400 mA ferrite bead TP1–TP3—Single-wire test points
TP4–TP7—Mini clips
20-conductor female connectors, 20-conductor ribbon cable, 26-conductor female connectors, 26-conductor ribbon cable, 4-conductor ribbon cable, case, hardware, etc.

Note: The following items are available from: Alta Engineering, 58 Cedar Lane, New Hartford, CT 06057-2905; Tel: (860) 489-8003; E-mail: alta@gutbang.com; Web: http://www.gutbang.com/alta: DOS software on 3½-inch disk, $10; Blank PC board, $45; Board Kit with software, $139; Board Kit with case and software, $169; Board Kit with case, software, and logic input probe assembly, $181. Please include $5 shipping/handling for US orders, $10 for international. CT residents must add appropriate sales tax. VISA and Mastercard are accepted.



When the digital-storage-oscilloscope module is hooked up to the logic analyzer, your setup will look like this. The combined instruments make an almost unbeatable pair for testing and troubleshooting both digital and analog circuits.

back to the first joint and retouch it if needed. After each capacitor is soldered in place, use an ohmmeter to check for any shorts across the capacitors that might have been caused by solder bridges.

Installing the surface-mount capacitors was good practice for soldering IC4, which we'll tackle next. Place that device in the correct location on the component side of the board and carefully align the leads so that they are centered on the pads. When you are sure of the alignment, carefully tack down pin 1 with a light touch of solder. That will hold the chip in place. Again, check the lead-to-pad alignment with a magnifying glass. If the alignment is not correct, re-melt the solder joint on pin 1 and readjust IC4 when it is free. Do not try to move the chip until the leads are free, or they will bend—a condition that is almost impossible to fix. Once the leads are lined up, solder pin 15. That will secure IC4 to the board. Carefully solder the remaining pins in place using a light touch and only enough solder to cover the joint. Do not solder pins next to each other. Instead, skip around the chip. That will prevent excessive heat from building up at any particular location. You should also not be in a rush to complete the task. When all of IC4's leads have been soldered, examine your workmanship with a magnifying glass. Look at the joints from several different angles to be sure that they are solid all the way around. Sometimes a bad joint can look good from the top, but it clearly is not properly bonded to the pad when seen from the side.

After taking a short break to relax, continue by mounting the rest of the capacitors and resistors. Keep in mind that IC4 is sensitive to static electricity—take the proper electrostatic-discharge precautions when handling the board. Note that most of the resistors are mounted vertically.

Next, mount L1 and the connectors in place. If you are going to be using a ferrite bead instead of the RFI filter for L1 (see Parts List), thread the bead onto a length of wire and solder it into the two outer holes—the center hole remains unused.

The voltage regulators should be mounted before the rest of the semiconductors. That way, you can do some simple checks of the power supply before installing the rest of the integrated circuits. If you want, you could use a socket for IC12. Once IC7–IC12 are mounted, check for any shorts between the 12-volt input on J2 and ground. If there are no shorts, or any shorts you found have been fixed, temporarily connect a 12-volt supply across pin 1 (12 volts) and pin 25 (ground) of J2. The voltage at pin 8 of IC12 should be 12 volts. Use the schematic diagram in Fig. 1 to test the volt-

SOFTWARE CONTROLS FOR THE DIGITAL-STORAGE OSCILLOSCOPE

F1—Scope mode. This selects the mode of operation from CONTINUOUS, SINGLE or NORMAL. In CONTINUOUS mode, the scope ignores any trigger conditions and continuously acquires and displays data. That mode is useful to view DC signals and to adjust the gain pot and offset pot or to determine the trigger levels. In NORMAL mode, the scope acquires and then displays only when the trigger condition is met. That mode is like the standard sweep-trigger mode in an analog oscilloscope except that you can view data from before as well as after the trigger. The SINGLE mode is the same as the NORMAL mode except that only one sample of data is acquired and displayed.

F2—Trigger level X/16 of full scale. This sets the trigger level for channel A in relation to the full scale of channel A. For example, if it is set for 8/16 then the trigger level is at mid-scale.

F3—Trigger slope ±. This sets the trigger slope to either rising ("+") or falling ("-"). If the trigger is set for 8/16 and the slope is set to rising, then the trigger will occur when the input signal rises from below mid-scale to above mid-scale.

F4—Trigger mode SCOPE/DIGITAL. This selects the type of trigger from either SCOPE for normal scope triggering using the level and slope of the channel A signal or digital logic triggering using the logic inputs 0 (TP4) and 1 (TP5). The logic trigger operates in the same manner as the logic analyzer trigger. See the discussion of logic triggering in that article for a complete explanation.

F5—Clock rate. This selects the clock rate at which the DSO acquires data. You can select any clock rate from 312.5 kHz to 40 MHz. At a rate of 40 MHz, a sample is taken every 25 nanoseconds. Using a lower rate lets you acquire and view data over longer periods.

F6—Acquire. This starts the data acquisition and display. Each scope channel has a separate grid and the four logic channels are at the bottom of the screen. Each channel is labeled on the left-hand side of the screen. The trigger location is shown by a short vertical line at the top of the grids if the trigger position is within the display. The time displayed at the top left of the grid is the number of microseconds at the start of the grid in relation to the trigger position. For example, a time of –3.2 microseconds shows that the displayed data starts at a point 3.2 microseconds before the trigger. If the time is positive, it means that the data shown is from after the trigger. You can view more of the data using the PageDown and PageUp keys to move back and forth one screen of data at a time. The END and HOME keys will jump to the start or end of the data sample. Press the escape key at any time to return to the menu.

F7—Display. This option displays the data currently stored in the program. When the program is first started before any samples have been taken, it will show some sample data that is a sawtooth waveform. You can also use this option to view data that has been recalled from a data file that has been stored on disk (see F8). The PageDown, PageUp, HOME and END keys work the same way as with F6 (Acquire).

F8—File. This option lets you save data and setup information to a file on disk for later viewing. You can also load saved data from a file with this option. The archive ALTADSO.ZIP has several data files that you can view. The CALLO, CALHI, CALCAL files are examples of correct probe compensation. The file VIDEO.DAT shows data captured from a composite video signal.

F9—Configure. This is the same as the configure option for the logic analyzer. If you have already configured the logic analyzer, you do not need to use this option.

F10—Exit. This quits the DSO program.

age at each pin location for all of the ICs. The voltages should be +5 volts, +8 volts, or –8 volts, as shown in the schematic diagram. Any problems should be tracked down and fixed before continuing.

When mounting the ICs, you may use sockets for all of the components except IC1 and IC2—those parts should be soldered directly to the board. Since the ICs are orientated in different directions on the board, double-check their orientation before soldering. It is a good idea to repeat the power-supply test with the ICs in place to catch any other assembly errors.

The three test points will need to be covered with insulating tubing to a height of a little more than a half inch if the case you will be using has a metal panel. You can use ribbon wire that has been split down and partially separated or individual lengths of stranded wire for the digital probes connected to TP4–TP7. A good length for the wires is 12 inches, but they should not be longer than 18 inches. A set of jumper cables should also be made from 20-conductor and 28-conductor ribbon cable. Those cables will connect the DSO to the logic analyzer. The lengths of the cables should be as short as possible to reach between the connectors between the two units. A length of about 2½ inches should be about right.

Drill appropriate holes in the front panel of the enclosure that you will be using for the DSO. Mount the completed PC board to the back of the front panel with screws and threaded standoffs. The DSO is now ready for testing.

Testing the DSO Module. The logic-analyzer module should be connected to a computer and turned off. Connect the DSO to the logic analyzer with the ribbon cables and turn the logic analyzer on. You should check for +12 volts at pin 8 of IC12 on the DSO board. If that voltage is not there, you should shut off the power immediately and track down the cause of the problem.

You should have the program ALTADSO.EXE in the same directory on your PC as the logic-analyzer program ALTALOG.EXE. Both programs use the same configuration file, so once you have the logic analyzer configured, it will not be necessary to configure the DSO. Both programs are very similar, so once you are familiar with the logic-analyzer program, you will also understand the basics of the DSO program.

Start up the ALTADSO program from the DOS prompt. Press the F1 key and set the option to "SINGLE". Connect the logic probe from TP7 to TP1, then acquire a sample. The display should look like an oscilloscope screen with the four digital channels showing at the bottom of the display. The very bottom trace is from TP7; it should be showing a square-wave signal that alternates between the low and high levels. Press the escape key to return to the main menu. Repeat that test with the other probes and verify that they all produce squarewave signals.

Connect a scope probe to the BNC connector of channel A. A standard 10X probe rated at 60 MHz can be purchased from a number of mail-order sources for under $20. If

the probe has a 1X–10X–REF switch, set the switch to "REF," otherwise, short the probe tip to the ground clip. Set F1 to CONTINUOUS mode and press F6 to begin acquiring samples. You should see a level trace in the top part of the grid that has an "A" on the left side. Turning R14 should move the trace up or down on the grid. There might be a short delay between adjusting the pot and seeing the results on the display, which is normal. Switch the probe to "10X" and connect it to TP1. You should see a squarewave signal on the A channel. Turning R8 will change the amplitude of the squarewave. If everything is working as described, test the B channel in the same way. If not, use a voltmeter to trace the signal path through the op-amp circuit looking for errors. When everything is working properly, mount the board in the case.

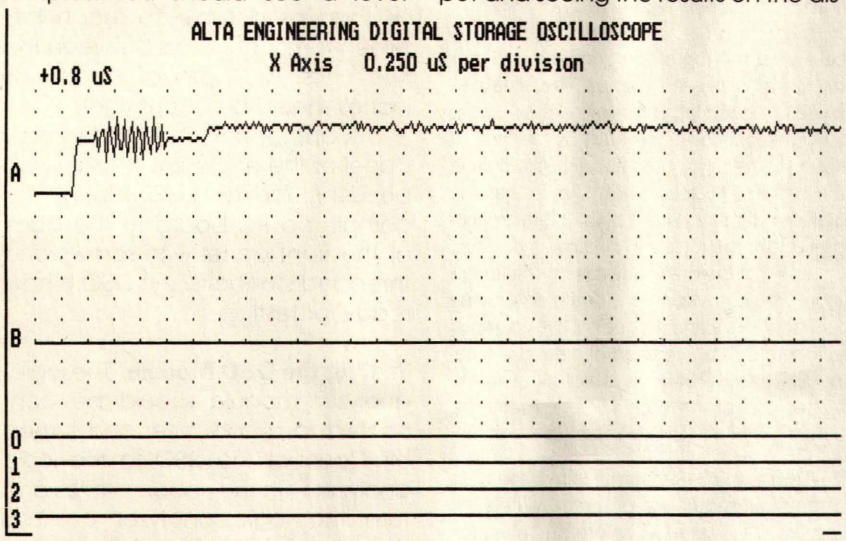
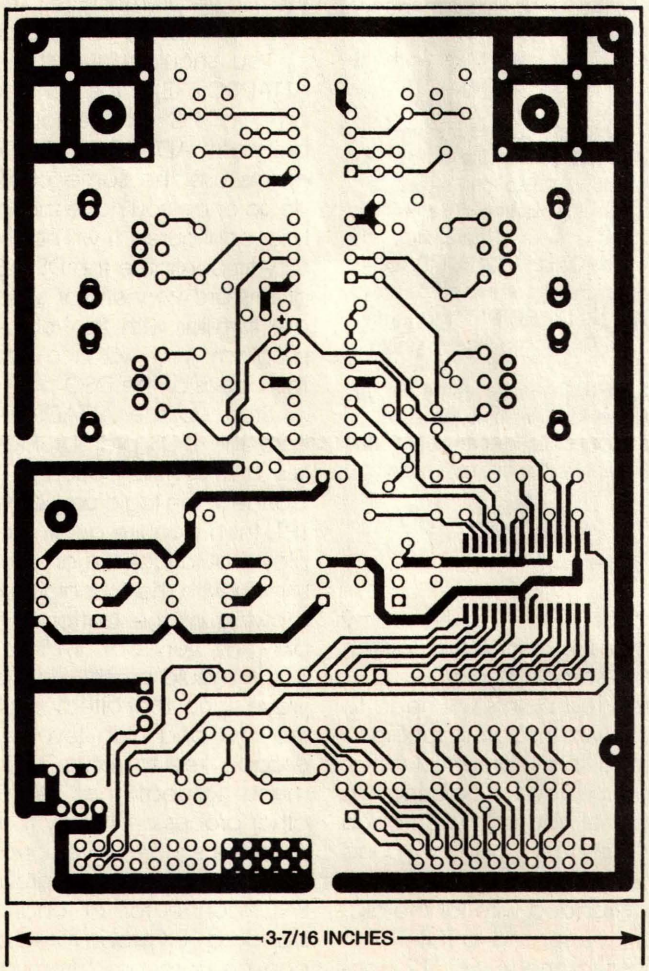


Fig. 3. The DSO software turns an IBM PC into a sophisticated piece of test equipment. As seen in this screenshot, there are two analog channels plus four digital channels. What's more, the software will work with a graphic display as low-resolution as CGA!

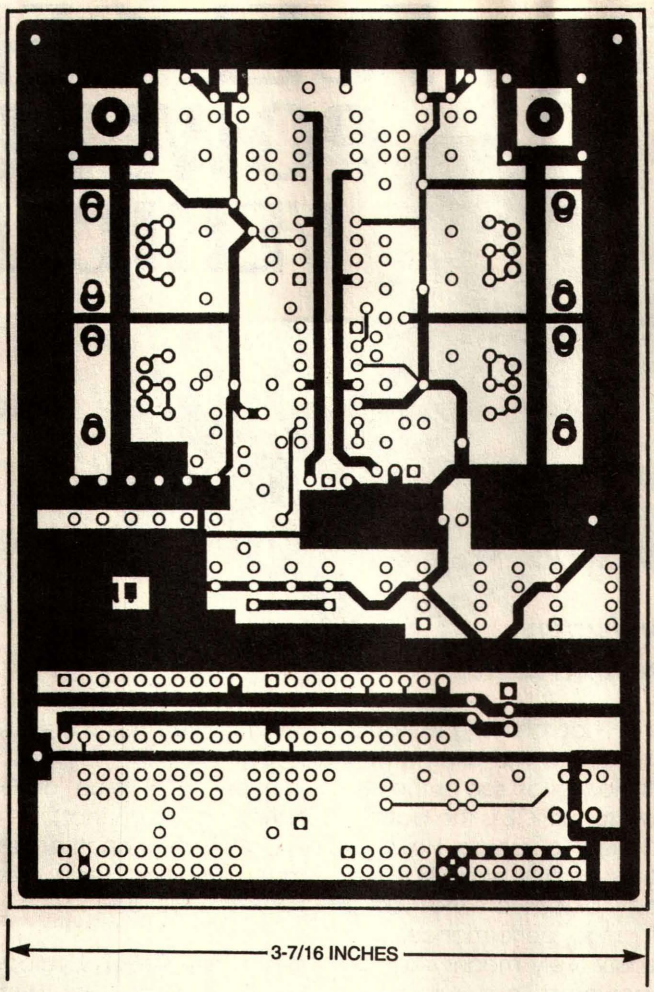
Probe Compensation. All 10X scope probes have an adjustment that is used to match the probe to the scope input. Once a probe is adjusted to match a particular channel, that probe should always be used with that particular channel.

The adjustment procedure for the DSO module is slightly different from most scopes. Begin by setting the probe switch to "10X" and connect it to TP2. Select the CONTINUOUS mode with F1 and then start to acquire samples with F6. You should get a flat trace on the display grid. Use R14 to move the trace to the first grid line from the bottom of the grid display for that channel (remember, channel A covers the top part of the scope grid). Once the trace is on the correct grid line, connect the probe to TP3. Now use R8 to bring the trace to the second grid line from the top of the display. Once that trace is at the correct grid line, you should move the probe to TP1. The display will show a squarewave. Without touching any of the potentiometers on the DSO, adjust the probe's compensation until the top and bottom of the squarewave is at the same grid lines that were used for setting R14 and R8. Repeat the procedure for the other channel. A different probe should be used with each channel; mark each one as to which channel it was calibrated for. If you are not sure about the level settings for probe compensation, detailed information is built into the program and can be viewed by pressing F7 or F8.



Using the Digital-Storage Oscilloscope. At this point you are ready to use the Digital-Storage Oscilloscope. However, before you dive in and begin experimenting with the DSO, there are two important warn-

Here's the foil pattern for the component side of the DSO board.



Here's the foil pattern for the solder side of the board. If you make your own board, the holes should be plated through.

ings that you should keep in mind. First of all, the maximum input voltage with the probes in 10X mode is ±60 volts; with the probes in 1X mode it is only ±8 volts. The second point is more important—before hooking up the DSO to a new circuit, check to be sure that there is no AC potential between the grounds of the circuit and the DSO.

A typical display of the DSO software is shown in Fig. 3. You have already become somewhat familiar with a few of the DSO's operational modes from testing and calibrating. See the sidebar for a more detailed explanation of each menu option.

To experiment with the various options, hook up the channel A probe to the TP1. Set the scope mode to NORMAL, the trigger mode to SCOPE, the trigger level to 8/16, and the slope to "+". Press F6 to acquire a sample. You should see a squarewave with the rising edge of the signal under the little trigger-position mark. Press the escape key and then set the trigger slope to "–". Press F6 to acquire another sample, and the trigger-position mark will be over the falling edge of the squarewave. When the trigger is set correctly, a repetitive signal should be steady in the display. You can experiment with the gain and offset adjustments and the other trigger settings using TP1. Remember, if the trigger condition is not met, the display will not be updated.

A Digital-Storage Oscilloscope is probably one of the handiest instruments to have on a test bench. The author welcomes questions, comments, and suggestions. He can be contacted through e-mail at alta @gutbang.com, by telephone at (860) 489-8003, or by visiting the Alta Engineering Web site at http://www.gutbang.com/alta. Ω

INFOCARD CARD SCANNER

(continued from page 42)

(which has a Triac-controlled output) can be used to control AC-based devices. With a simple transistor switch, a small relay could also be activated. If you do not want to remove LED1, the demonstration program also activates pin 3 of the printer port along with LED1. Multiple output circuits can be hooked up to pins 4 through 9 with modification to the program. If you use that pin, be careful of any circuit that you connect to the computer's hardware—you might end up damaging your printer port.

TABLE 1

J1 Pin No.	BASIC Function
10	INP (*address*) AND 64
11 I	NP (*address*) AND 128
12	INP (*address*) AND 32
13	INP (*address*) AND 16

Multiple InfoCards can be hooked up to the same computer if, for example, you want to read cards from different locations. The basic circuit built around IC2-b is all that is needed. If you do not use LED1, a single LM339 can be used for up to four InfoCard stations. Of course, the program will have to be modified to accept input from the different stations. Table 1 shows how to change the input statement in the program to read card information from different input pins.

The InfoCard software could also be integrated into another program or batch file to control access to lists or other data in the computer depending on a card's code. You can modify the program to have multiple access codes. You can also add routines to look up the code in a database to provide related information about the card holder. How you use the InfoCard is limited only by your imagination! Ω

It could be a best seller. But it's free.

To get your free catalog, write:

Consumer Information Center
Dept. BEST, Pueblo, CO 81009

FUEL-CELL POWERED VEHICLES

Are fuel cells the technology that will allow us to replace the polluting internal-combustion engine with a cleaner, good-performing alternative?

BILL SIURU

It is hard to beat the internal-combustion engine (ICE) when it comes to performance, range, cost, safety, reliability, and user-friendliness. After all, it has been "under development" for over a century. However, there are several compelling reasons to replace the ICE with a different technology.

For one, there is the matter of petroleum resources. The U.S. now imports nearly half of all petroleum consumed by cars and light trucks. That will increase as the number of vehicles and miles driven continues to increase.

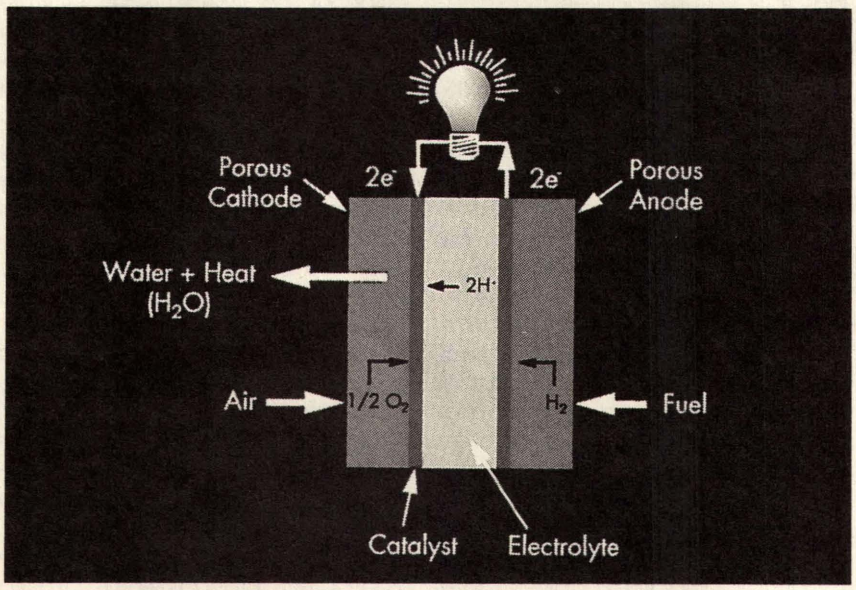
Also, many scientists postulate that global warming results from greenhouse gases, which are produced when fossil fuels are combusted. As such, one of the most significant source of greenhouse gases is the automobile.

Is it possible to reduce those problems by further refining the ICE? Perhaps, but likely not enough to do more than delay the day of reckoning somewhat. Even with the most sophisticated electronic fuel-injection systems and the use of alternative fuels like natural gas, methanol, and ethanol, the ICE cannot meet the zero-emission-vehicle (ZEV) mandates already legislated in California, New York, and Massachusetts and under serious consideration in other states and Canadian provinces.

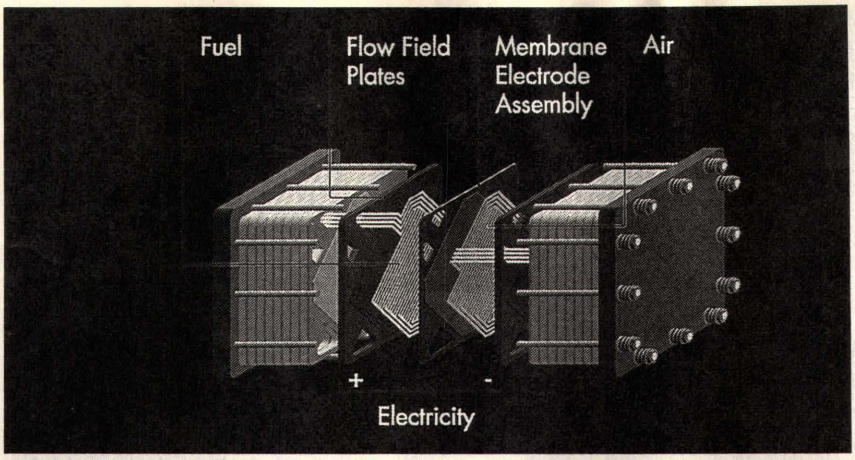
So, other than banning the automobile, what are the alternatives? The technology most see as the best alternative to the ICE is the battery-powered electric vehicle. However, at the present, the limits that that technology places on the user in terms of range, performance, cost, and flexibility likely means that the battery-powered car will never replace the ICE except in narrow niche markets such as for urban transport and as neighborhood electric vehicles (See "Neighborhood Electric Vehicles" in the January 1998 issue of **Electronics Now** for more on that).

But there is another technology that is getting serious consideration—the fuel cell.

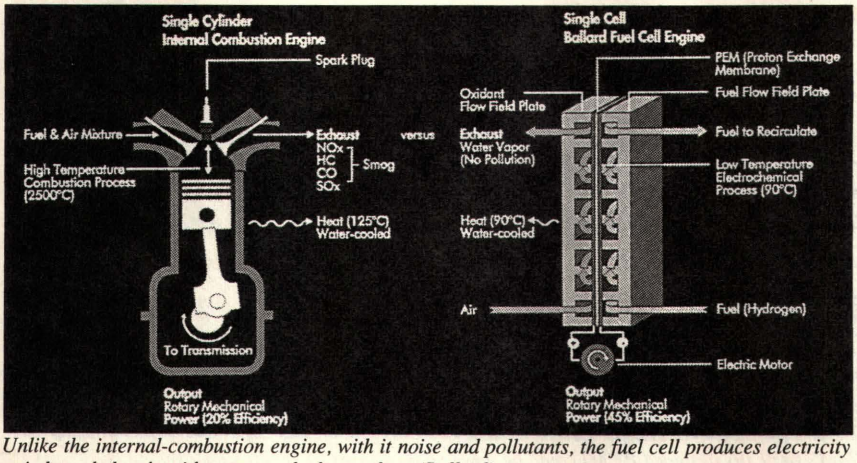
Why Fuel Cells? Hydrogen is the ultimate clean fuel. When combined with air to produce energy, only heat, water, and a small amount of oxides of nitrogen (NOx)



How a fuel cell works. Each membrane assembly consists of electrodes (anode and cathode) with a thin layer of catalyst, bonded to either side of a proton-exchange membrane (PEM). Air flows through the channels in flow-field plates to the cathode. Oxygen in the air attracts the hydrogen protons through the proton-exchange membrane. The air stream also removes the water created as a by-product of the electrochemical process. (Ballard)



Stacking together more PEM cells increases the voltage, while increasing the surface area of the cells increases the current. (Ballard)



Unlike the internal-combustion engine, with it noise and pollutants, the fuel cell produces electricity quietly and cleanly with water as the by-product. (Ballard)

are produced as by-products. There are no greenhouse gases. Some say the 21st Century will be the "Hydrogen Century" as hydrogen replaces fossil fuels. Hydrogen is extremely abundant, indeed the most abundant element in nature, and is a renewable resource. It is available worldwide since it can be produced from many sources from natural gas to bio-mass including agriculture crops and landfill waste. Using electrolysis, hydrogen can be produced from water anywhere that electricity from any source—including "clean" ones such as wind, solar, or hydro power—is available.

All that sets the stage for the current intensive interest in fuel cells for automotive applications. Though the fuel cell was conceived in 1839 by Sir William Grove, it did not really see practical use until the space age when hydrogen-oxygen fuel cells supplied power onboard the Gemini, Apollo and Skylab spacecraft. They are currently used on the Space Shuttle.

How A Fuel Cell Works. Like a battery, a fuel cell is an electrochemical device that directly produces DC electricity without combustion and without producing polluting emissions. Like batteries, fuel cells have anodes, cathodes, an electrolyte, and positive and negative terminals. Unlike batteries, they do not have to be recharged. Fuel cells produce electric power as long as they are supplied with fuel (namely hydrogen) and oxygen or air.

Companies like Ballard Power Systems, International Fuel Cells, Plug Power, Mechanical Technology, Inc. and others are working on fuel cells for automotive applications. For instance, Ballard, located in Vancouver, British Columbia, has developed several versions of its Proton Exchange Membrane (PEM) fuel cells that have been installed in prototype cars and buses.

The PEM fuel cell consists of two electrodes (anode and cathode) separated by a polymer-membrane electrolyte. Each electrode is coated on one side with a thin layer of platinum catalyst. That catalyst causes the hydrogen fuel to separate into free electrons and protons (positive hydrogen ions) at the anode. The free electrons are conducted as usable electric current, passing through the external circuit. Like with battery-powered EVs, electrical energy from the fuel cell is supplied to an electric motor, or motors, to propel the vehicle. The protons migrate through the membrane electrolyte to the cathode, where they combine with oxygen from the air and electrons from the external circuit to form water and heat. The heat could be used for passenger comfort, windshield defrosting, etc. The output voltage of the fuel cell is increased by stacking individual cells in series; increasing the surface area of the cells increases the current produced.

Storing or Making Hydrogen On Board? Two quite different approaches are being considered with respect to the hydrogen fuel. The nearer term approach is to convert conventional fuels like gasoline, methanol, or ethanol into hydrogen on board the vehicle. The advantage of that technique is that the current infrastructure for transporting and distributing fuels would need little or no change and motorists would see little difference when they refuel.

The longer term approach is to store hydrogen on board as a compressed gas, cryogenic liquid, or in a hybrid material. On-board storage results in a simplified system with higher overall efficiency compared to on-board fuel processing. The disadvantage is that on-board storage requires a completely revamped transportation and distribution infrastructure to handle hydrogen. That could take years to put into place.

An example of a system to produce hydrogen on board is the reformer developed by the Argonne National Laboratory for producing hydrogen from methanol. In the Argonne reformer, a noz-

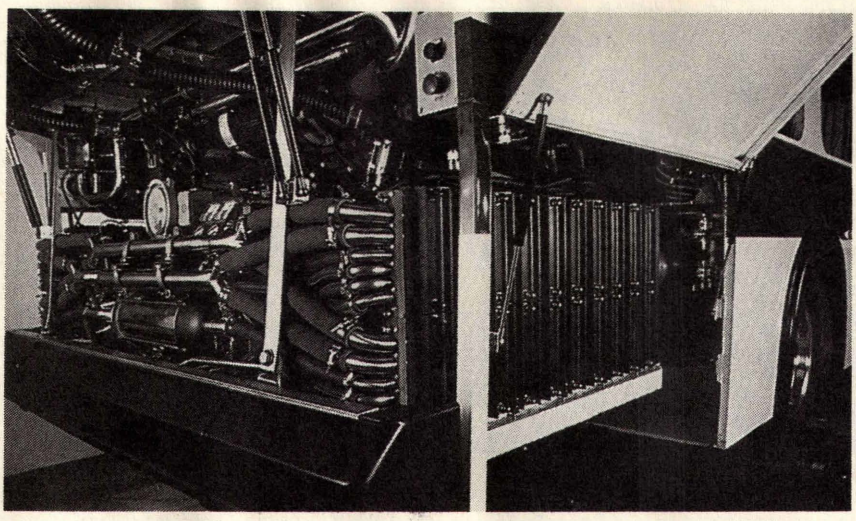
zle sprays liquid methanol into a cylinder and an ignition source starts the chemical process that combines methanol with oxygen from the air to release a hydrogen-rich mixture of gases. That hydrogen-rich gas mixture is injected into the fuel cell. Since the reformer produces both carbon dioxide and carbon monoxide, a small on-board chemical reactor converts the carbon monoxide into carbon dioxide.

Consisting basically of a cylinder packed with a common, inexpensive catalyst, the design is quite simple and would be inexpensive to manufacture. The device is small enough—it takes up less volume than a seven gallon container—to fit under the hood of a compact car. While not as efficient as an on-board hydrogen-storage system, the reformer/fuel cell system could be more efficient than an ICE, yet it produces negligible emissions besides carbon dioxide.

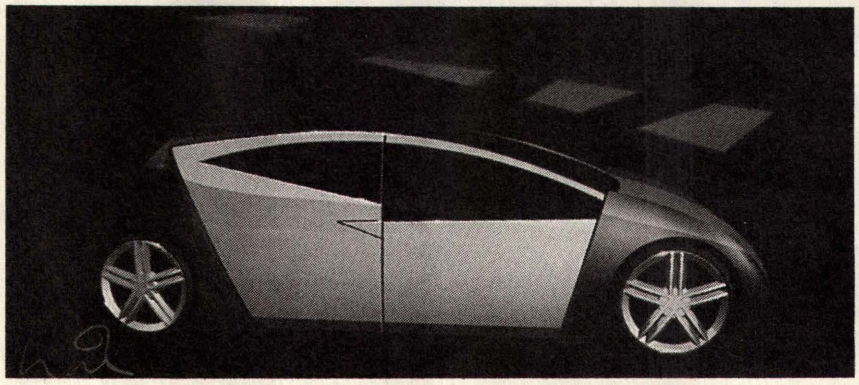
Recently, Plug Power LLC, the Arthur D. Little Research Foundation, and the Los Alamos National Laboratory have successfully developed a gasoline-to-hydrogen reformer. That represents a breakthrough in that it overcomes the problem of fuel-cell poisoning from the high levels of carbon dioxide produced when gasoline is reformed. That is why methanol is being used in other reformer developments.

Unfortunately, largely because of the Hindenburg disaster, extremely explosive hydrogen has a negative image to many people. The hydrogen-filled Zeppelin exploded over Lakehurst, NJ in 1937, killing 36 people. Thus, it could still be a hard sell to convince the public that hydrogen stored as a compressed gas or a cryogenic liquid is safe on the highway. Liquid hydrogen means storage at cryogenic temperatures, which is both complex and expensive. Current compressed gas and liquid hydrogen-storage techniques are heavy and bulky so they greatly limit the range of the vehicle—the same problem that faces battery-powered EVs.

Another solution is to use a metal-hydride storage system. Here, cold hydrogen is absorbed in the hydride material. When heated, the material releases gaseous hydrogen that could be used in a fuel cell. That storage technique is considered safer than either compressed gas or cryogenic storage because the metal hydride releases hydrogen slowly and at relatively low pressure. One drawback is that the storage equipment is still quite heavy and bulky. Therefore, it is most appropriate for use in large vehicles such as buses.



The 275-horsepower Ballard fuel-cell engine fits into the same space as a diesel bus engine. (Ballard)



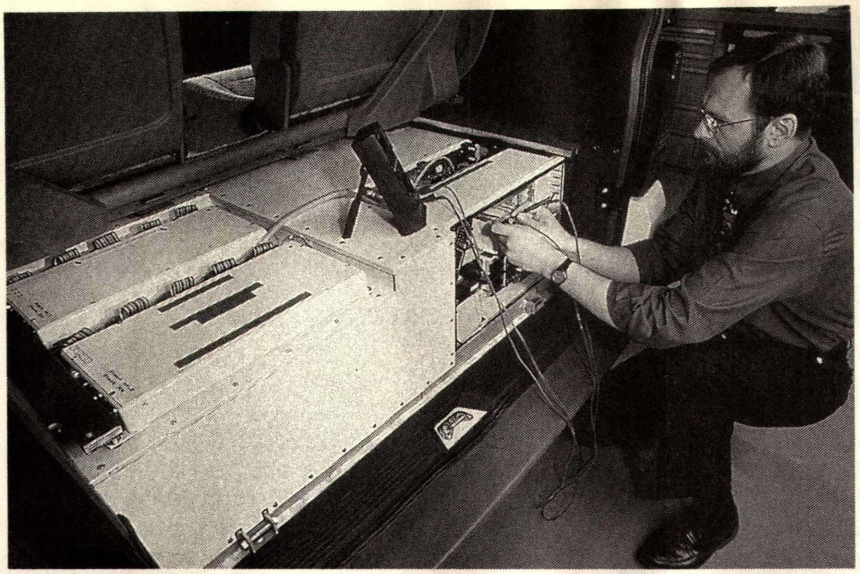
Ford's radically designed P2000 could be powered by a fuel-cell engine. (Ford)

Buses First. While it may be a while before fuel-celled passenger cars and light trucks are on the road, fuel-cell buses are already here, at least in demonstration programs under real-world conditions. Buses have the space and can carry the additional weight of fuel cells using today's technology. Also urban mass-transit agencies are interested in reducing emissions either voluntarily or in many cases, to meet government mandates for clean air. According to the California Air Resources Board, a heavy-duty diesel bus generates 11.8 tons of NOx over a 12-year life span. Even so-called clean buses operating on natural gas will emit 5.6 tons of NOx. A fuel cell bus can be designed to emit no NOx.

Ballard Power Systems chose transit buses as the first transportation application for its fuel cells. Ballard's, and the world's, first fuel-cell-powered transit bus went on the road in 1993. It was a 32-foot transit bus with a 125-horsepower Ballard PEM fuel-cell engine fueled directly by hydrogen.

In 1995, Ballard introduced its second bus, a 40-foot ZEV with a 275-horsepower Ballard fuel-cell engine. It has a range of 250 miles before refueling and matches the performance of a diesel transit bus, but without the noxious fumes; and it produces far less noise. The only emission from the tailpipe is warm, moist air.

This year, the Chicago Transit



The Ballard fuel cells fit under the backseat of the NECAR II minivan and do not reduce the seating or luggage capacity of the vehicle. (Ballard)

Authority and BC (British Columbia) Transit will each take delivery of three commercial prototype fuel-cell buses. The buses will undergo a two year test program that will provide the necessary performance, cost, and reliability data for commercialization of the final product.

Fuel-Cell Cars. Many automakers have fuel-cell R&D programs. Ford, General Motors, and Chrysler are conducting fuel-cell development as part of the Partnership for a New Generation of Vehicles (PNGV)—a partnership between the Federal government and the automakers' U.S. Council for Automotive Research (USCAR) coalition.

Ford is developing a full-performance direct-hydrogen PEM system as part of its P2000 project. "Direct" means that hydrogen fuel is stored onboard the vehicle. The P2000 project is aimed at producing a medium-sized family sedan that weighs only 2000 pounds, or about 1200 pounds less than a Ford Taurus, while being about three times as fuel efficient. Ford is working with International Fuel Cells, and Mechanical Technology, Inc. in this Department of Energy project. Ford recently announced it had demonstrated a 50 kW, automobile-size PEM fuel-cell engine. The system weighs 300 pounds and takes up approximately nine cubic feet, so it could easily fit under a car hood.

Chrysler's Pentastar program is working with Allied Signal on a Design-to-Cost Direct Hydrogen PEM system. Chrysler hopes to have a prototype gasoline-to-hydrogen fuel cell vehicle on the road by 1999. General Motors' Delphi Divisions plus Ballard and DuPont are working on a 30-kW methanol PEM system.

Daimler-Benz recently unveiled the NECAR 3, the third in a series of fuel-cell-powered "New Electric CARs." Over the past couple of years, Daimler-Benz has also developed the NECAR 1, NECAR 2, and NEBUS transit bus. All used Ballard fuel cells. Indeed, Daimler-Benz has acquired a 25% share in Ballard.

Unlike the previous three D-B fuel-cell vehicles, where the hydrogen was stored in heavy and bulky pressurized tanks, the NECAR 3's fuel is stored in rather ordinary fuel tanks. That is because the fuel is methanol. According to Daimler-Benz, methanol was chosen over gasoline and diesel because of its higher efficiency and lower emissions. However, the engineers are considering a multi-fuel system on early-generation fuel-cell-powered vehicles to allow for a phase-in period until methanol is readily available everywhere.

The NECAR 3's methanol reformer uses a water-vapor technique to convert methanol to gaseous hydrogen. Methanol and water vaporize at about 280 degrees C in the reformer to produce hydrogen plus carbon dioxide and carbon monoxide. Following catalytic oxidation of CO, the purified hydrogen is delivered to the fuel cell.

As a demonstration of the practically of its new reformer and fuel-cell technology, the NECAR 3 uses a new Mercedes-Benz A-Class subcompact, a 12-foot long four-door sedan. The compact reformer, which is only about 18-inches tall, is located behind the rear seat along with the methanol tank and control system. The A-Class's innovative double floor sandwich construction allows the fuel cells and auxiliary units to be installed completely under the passenger compartment. The 11-gallon fuel tank holds suffi-

(Continued on page 68)

FOR MORE INFORMATION

Ballard Power Systems Inc.
9000 Glenlyon Parkway
Burnaby, BC Canada V5J 5J9
Web: www.ballard.com

Chrysler Corporation/Fuel Cell Program
30900 Stephenson Highway
Madison Heights, MI 48071
Tel: 810-583-5270; 810-583-5234

Energy Partners
1501 Northpoint Parkway, Suite 102
West Palm Beach, FL 33407
Tel: 561-688-0500
Fax: 561-688-9610

Ford Motor Company/Alternative Power Source Technical Department
PO Box 2053
Dearborn. MI 48121-2053
Tel: 313-594-7957
Fax: 313-845-4495

Fuel Cells 2000
1625 K Street NW, #790
Washington, DC 20006
Tel: 202-785-9620
Fax: 202-785-9629
Web: www.fuelcells.org

General Motors/AC Rochester
PO Box 20366
Rochester, NY 14602
Tel: 716-359-6423
Fax: 716-359-6015

International Fuel Cells
PO Box 739
195 Governors Highway
South Windsor, CT 06074
Tel: 860-727-2310
Fax: 860-727-2399

Mercedes-Benz of North America
One Mercedes Drive
Montvale, NJ 07645-0350

NATIONAL ELECTRONICS TECHNICIAN'S DAY 1998

Promote your career and join the ranks of the professional electronics technicians who've proven their expertise and earned the designation of CET.

ALICE BROWN

Since its founding in 1970, The International Society of Certified Electronics Technicians, (ISCET) has developed and implemented programs and services to help the working technician remain competent and to continue to develop skills and technical expertise. During that time, ISCET has certified over 44,000 technicians nationwide and in over 40 foreign countries, provinces, and territories, while continuing to set industry standards to assure this country's continued technological and economic leadership. To recognize that achievement, to honor the technician's who have demonstrated their skill and high performance by becoming Certified Electronics Technicians (CETs), and to encourage working technicians to join the ranks of their colleagues who have attained the CET designation, ISCET established *National Electronics Technician's Day* in 1986 as a special day set aside for the certification of technicians worldwide. For this year, that special day, officially declared as "T-DAY," is set for Tuesday, April 21, 1998.

The CET Program. The CET program

VOLUNTEER CET EXAMINERS

Cindy Johnson, CA
280 West Vly Ave
Birmingham, AL 35209
205-916-2800
205-916-2807

Alfred Jones, CET, CA
Lawson St Comm College
3060 Wilson Rd
Birmingham, AL 35221
205-925-2515
DJones@kibanet.com

James Lockhart, CET, CA
ITT Tech Inst
500 Riverhills Business Pk
Birmingham, AL 35242
205-991-5410
205-991-5025

Susan Gann, CA
ITT Tech Inst
500 Riverhills Business Pk
Birmingham, AL 35242
205-991-5410
205-991-5025

Tony Jetton, CET, CA
Wallace St College
Box 2000
Hanceville, AL 35077-2000
205-352-8160

Ricky Reaves, CET, CA
Shoals Comm College
Box 2545
Muscle Shoals, AL 35662
205-331-5201
205-331-5200
205-331-5222
800-645-8967

David Bryan, CET, CA
AL Aviation College
Box 1209
Ozark, AL 36360
W-205-774-5113
H-205-774-0163

R.T. Van Iderstine, CET, CA
14563 South Blvd
Silverhill, AL 36576
334-945-5942

Daniel McCAnn, CET, CA
QMS Inc
30949 Wellington Ct
Spanish Ft, AL 36527
W-334-633-4300 X-2047
H-334-621-8163
dmcCAnn@rd.qms.com

Kristi Lashlee, CA
PO Box 909
Searcy, AR 72143
501-268-6191

Dennis Blum, CET, CA
8730 W Hazelwood
Phoenix, AZ 85037
602-872-8564
602-279-2999
schemati@aztec.asu.edu

HJ Paine, CET, CA
4631 E 8th St
Tucson, AZ 85711
520-881-6784
520-795-1209
kirshna@azstamet.com

Parviz Shams, CA
So CA Inst Of Tech
1900 W Cresent-Bldg B
Anaheim, CA 92801
714-520-5552

Romualdo Malarayap, CET, CA
4249 Filhurst
Baldwin Park, CA 91706
626-962-3631

Jim Hines, CA
Fresno Tech
731 W Shaw Ave
Clovis, CA 93612-3217
209-442-3500

Michael Maxwell, CET, CA
St Agnes Med Cntr
1303 E Herndon Ave
Ms 040
Fresno, CA 93720
209-449-3512
209-449-3030
maxwmi@samc.com

David Marson, CET, CA
Mac Doctor
1040 W Kettleman Ln#1b339
Lodi, CA 95240-6056
209-944-6191 X6698
Macdoc@CAlweb.com

Jerry Mendoza, CET, CA
4601 Lexington #111
Los Angeles, CA 90029
213-667-1732

Michael Miller,Vo Instr
1205 Bay Oaks Dr
Lososos, CA 93402
805-547-7900 X 7143

John Craig, CET, CA
NSWC
531 W Hueneme Rd
Oxnard, CA 93033
805-982-9803
805-986-2504

George M Kirby, CA
ITT Tech Inst
10863 Gold Center Dr
Rancho Cordova, CA 95670-6034
916-851-3900
916-851-9225
gjkir@inreach.com

Jon Sturtz, CET, CA
10840 Alandale Way
Rancho Cordova, CA 95670
916-635-6000

Steven Thomas, CET, CA
2306 Marilyn Ave
Redding, CA 96002-2304
916-222-2541
916-243-2267
pilotst@nstate.net

Peter Moreno, CET, CA
ITT Tech Inst
630 E Brier Dr #150
San Bernardino, CA 92408
909-889-3800

Dr Kenneth Wilson, CET, CA
San Diego Cty College
1313 12th Ave
San Diego, CA 92101
619-230-2601

Charles Trout, CET, CA
Service Concepts Inter Inc
563 N Fairview St
Santa Ana, CA 92703
714-836-4981
714-569-0204

Don Winchel, CET, CA
M & D Elect
Box 123
Smartville, CA 95977
530-639-2477
530-639-2477
dwinchel@mako.com

Howard Bardach, CET, CA
13251 Ventura Blvd #D
Studio Cty, CA 91604-1838
818-995-8648
818-995-8647

Marjorie Lona, CA
Colorado Aero Tech
10851 West 120th Ave
Broomfield, CO 80021
303-466-1714 X-273
800-888-3995

Ken Hill, CET, CA
400 CR 230
Durango, CO 81301
970-247-3032
970-565-8457

George Shaiffer, CET, CA
38 N Dartmouth
Widefield, CO 80911
719-540-7458
719-392-1000
719-540-7453

Daniel Shea, CET, CA
CT School Of Elect
586 Ella T Grasso Blvd
New Haven, CT 06519
203-624-2121

Scott Latino, CET, CA
Bombardier Aviation Serv
1 Bradley Internationl Airport
Windsor Locks, CT 06096
860-292-7219

Albert Moses, CET, CA
Box 188
Cheswold, DE 19936
W-302-736-3816
H-302-653-5648

Karl Hunter, CET, CA
13850 Ketch CV Dr
Jacksonville, FL 32224-1143
W-904-633-8143
H-904-223-5289

Edward Guary, Sr, CET, CA
Eddy's Car Radio
2505 US 60 E
Lake Wales, FL 33853
941-679-7507

John S Richards, CET, CA
ITT Tech Inst
2600 Lake Lucien Dr
Ste 140
Maitland, FL 32751
407-660-2900
407-660-0694
wizsteve@gte.com

James Sullivan, CET, CA
ITT Tech Inst
7955 NW 12th St #119
Miami, FL 33126
305-477-3080
305-477-7561

James D Drennen, CET, CA
Pensacola Jr College
1000 College Blvd
Pensacola, FL 32504
904-484-2592
850-484-2597
jdrennen@pjc.cc.fl.us

Ronald Handlon, CET, CA
Tampa Tech Inst
2410 E Busch Blvd
Tampa, FL 33617
W: 813-935-5700
H: 813-898-3970

Dennis Abell, CET, CA
3433 Royal Oak Dr
Titusville, FL 32780
407-269-4208

Alan Besore CET, CA
New England Inst Of Tech
1126 53rd Ct
W Palm Beach, FL 33407
800-826-9986
561-842-9509

VOLUNTEER CET EXAMINERS

Robert Laquerre, CET, CA
New England Inst Of Tech
1126-53rd Court
W Palm Beach, FL 33407
561-842-8324
boblaq@earthlink.net

Donald K Dahms, CA
Atlanta Tech Inst
1560 Metropolitan Pkwy SW
Atlanta, GA 30310
404-756-3786
404-752-0180
ddahms@admin1.Atlanta.Tec.ga.us

Dan Mundy, CET, CA
Norman's Elect
3653 Clairmont Rd NE
Atlanta, GA 30341
404-373-8037
71241.336@COM PUSERV.COM

James Vansant, CET, CA
Pickens Tech
100 Pickens Tech Dr
Jasper, GA 30143
706-692-4500
706-692-4510
jvansant@admin1.pickens.tec.ga.us

John Carolus, CET, CA
Matsushita
1225 Northbrook Pkwy 2-380
Suwanee, GA 30174-2933
770-338-6875

Joe Reese, CET, CA
Reese Elect Inc
Box 499
301 South Main St
Swainsboro, GA 30401
912-237-7010
912-237-7463
jreese@pinelanl.neti

William Doi, CET, CA
Doi's Elect Svc
105-a N Kainalu Dr
Kailua, HI 96734
808-261-6911

Leonard Bowdre, CET, CA
125 SE Thornton Ave
Des Moines, IA 50315
W-515-964-6484
H-515-282-3028
lebowdre@dmarc.cc.ia.us

Donnin Custer, CET, CA
West IA Tech Comm College
Box 265-4647 Stone Ave
Sioux City, IA 51102-0265
712-274-8733 X-1392

Bruce Tietjen, CET, CA
204 Northgate Mile
Idaho Fls, ID 83401
208-523-5045

Dr Harvey Franklin, CA
500 Eighth Ave
Lewiston, ID 83501
208-799-2220

Eddie Lane, CET, CA
1501 Honeysuckle
Champaign, IL 61821
W-217-333-1070
H-217-356-6996

Fred Schwarzkopf, CET, CA
3708 W 83 Place
Chicago, IL 60652
773-767-4126 X-563

Paul R Trowbidge, CA
Drive Controls Inc
3232 Skokie Rd
Highland Park, IL 60035
847-433-0755
847-662-1563

Paul Tan, CET, CA
915 Augusta St#1
Oak Park, IL 60302-1678
708-848-6327

Lonnie Lewellen, CA
Ivy Tech State College
4475 Central Ave
Columbus, IN 47203
812-372-9925

Matthew A Dillman, CA
Ivy Tech State College
3501 First Ave
Evansville, IN 47710
812-429-1479

Paul F Maglinger, CET, CA
901 Dover Ct
Evansville, IN 47710
812-464-2523
812-421-2170
pmagling@clrtechnol.com

Don Williams, CET, CA
Vincennes Univ-TB10
1002 N First St
Vincennes, IN 47591
812-885-5801
812-922-5670

Christopher Smith, CA
Purdue Univ-N Central
1401 South US 421
Westville, IN 46391
219-785-5256
219-785-5539
csmith@purduenc.edu

Stanley Creitz, CET, CA
Comm Services
Rr 4 Box 72
Beloit, KS 67420
913-738-5095
screitz@nckcn.com

Keith Knos, CET, CA
Knos Elect
1206 Elm Blvd
Liberal, KS 67901
316-624-5908

Sharon West, CA
Johnson Cnty Comm College
12345 College Blvd
Overland Park, KS 66210
913-469-4439

John Hardin, CET, CA
KT Tech-Ashland Rtc
4818 Roberts Dr
Ashland, KY 41102
606-928-6427
606-329-7136

Danny Keeton, CET, CA
55 W Airview Dr
Elizabethtown, KY 42701
502-769-6606
502-769-8278

Lamarr Ritchie, CET, CA
Hazard Reg Tech Cntr
101 Vo-tech Dr
Hazard, KY 41701
606-435-6101
606-476-8714
lamarr@geocitips.com

Jerry Sipes, CA
Spencerian Colge-Lexington
3330 Partner Pl Ste 1
Lexington, KY 40503
606-223-9608
606-224-7744
S4744@gte.com

Edward Kimmel, CET, CA
Kimmel Elect
2061 Eastern Pkwy
Louisville, KY 40204
502-451-3457

Donald Johnson, CA
Inst Of Elect Tech
509 S 30th St
Paducah, KY 42001
502-444-9679

Jesse Adkison, CET, CA
Inst Of Elect Tech
509 S 30th St
Paducah, KY 42001
502-444-9676
502-345-2061

Michael Dixon, CET, CA
KY Tech-Somerset Campus
230 Airport Rd
Somerset, KY 42501
606-679-4303

Dr I F Creel, CET, CA
Louisiana Tech College
1710 Sullivan Dr
Bogalusa, LA 70427
504-732-6640
504-732-6603
fcreel@communique.net

Don Creech, CET, CA
712 Ronson Dr
Kenner, LA 70065
504-467-4644

Jeffrey Luminais, CET, CA
4014 Arkansas
Kenner, LA 70065
504-888-6848

James Sorrels, CET, csm, CA
Polytronics
8101 Kingston Rd #102a
Shreveport, LA 71108-5745
318-688-2952
318-688-4888
polytronics@internetmci.com

Frank Serra, CET, CA
Audiosonics Inc
159 Mass Ave
Arlington, MA 02174
781-648-2430
781-648-2431

Don Harris, CA
RETS Elec Sch
965 Commonwealth Ave
Boston, MA 02215
617-783-1197

Robert Braunston, CET, CA
RETS Elec School
965 Commonwealth Ave
Boston, MA 02215
617-783-7197

Earl Tickler, CET, CA
RETS Tech Trng Cntr
1520 S Caton Ave
Baltimore, MD 21227
410-644-6400
410-644-6481

Carl Miller, CET, CA
TESST
5122 Baltimore Ave
Hyattsville, MD 20781
301-864-5750

Bob Bellers, CET, CA
Washtenaw Comm College
4800 E Huron Riv Dr
Ann Arbor, MI 48106
313-973-3316
BBEL373@orchard.washtenow.cc.mi.us

Naomi Ludman, CA
Southwestern Michigan Colge
58900 Cherry Grove Rd
Dowagiac, MI 49047
616-782-1329

John Thennes, CET, CA
2102 10th Ave S
Escanaba, MI 49829
906-786-1413

Gerald Heyn, CET, CA
WNMU-TV, WNMU-FM
132 Blueberry
Gwinn, MI 49841
906-346-6396H
gheyn@nmu.edu

Walter Reilly,III, CET,CSM, CA
WER Inc
2727 E Kalamazoo
Lansing, MI 48912
517-485-1737
517-485-9555
RS2K23A@PRODIGY.COM

Larry Geissler, CET, CA
3706 Chambersburg
Duluth, MN 55811
218-722-9356
lgeiss@theonramp.net

Jim Hunsucker, CET, CA
N Cntrl Area Vo Tech
Hwy 69 Spur N
Bethany, MO 64424
816-425-2196
jhunsucker@shr2.k12.mo.us

William Tharp, CET, CA
Grand River Tech Sch
1200 Fair
Chillicothe, MO 64601
816-646-3414
816-646-3568
tharpbil@grt.chillicothe.k12.mo.us

Annabel Gooch, CA
MAVTS
905 N Wade St
Mexico, MO 65265
573-581-0752
573-581-7084
AGOOCH@mexicok12.mo.us

Michelle A Stein, CA
Moberly Area Vo Tech
1625 Gratz Brown
Moberly, MO 65270
816-269-2631
816-269-2692

Marion Denny, CET, CA
Rapid TV-Elect Repair
1909 6th St
Meridian, MS 39301
601-485-8453
601-485-2102
rpdtpr@intop.net

Joseph Sloop, CET, CA
Surry Comm College
Dobson, NC 27017
910-386-8121 X-301

Linda Dickinson, CA
Craven Comm College
Ste 22 E Plaza
Professional Cnt
Havelock, NC 28532
919-444-6005
919-444-1918

Earl Fosler, CET, CA
Southeast Comm College
4236 Ridge Lea Rd
Milford, NE 68405
402-761-8266
402-761-2324
erfosler@sccm.cc.ne.us

Jack Hopson, CET, CA
First Telev Svc
5214 Center
Omaha, NE 68106
402-556-4018
402-551-4870

Franklin Davy, CET, CA
PO Box 1889
Hillsboro, NH 03244-1889
603-478-5716

Edward Leduc, CET, CA
319 S Hall St
Manchester, NH 03103-3955
603-669-1533

Joseph Szumowski, CET, CA
JTS Elect
412 Pomona Rd
Cinnaminson, NJ 08077
609-829-9669
cinntron@aol.com

Anthony Baratta, CET, CA
RETS Inst
103 Park Ave
Nutley, NJ 07110
973-661-0600 X-30
973-661-2954

Antonio Mares, CET, CA
Luna Vo Tech Inst
PO Box 2969
Las Vegas, NM 87701
505-425-5600

Fred Freeman,Jr, CA
550 Tabany Ave
Henderson, NV 89015
702-564-9163

David Law, CET, CA
Alfred St College
222 Brown Hall
Alfred, NY 14802
607-587-3468
607-587-3291
LawsL@alfredtech.edu

Carl Meyer, CET, CA
AFPS Inc Test Lab
4236 Ridge Lea Rd
Amherst, NY 14226
716-835-6664

Gregory Reiber, CET, CA
9553 Bantry Rd
Brewerton, NY 13029-9543
315-668-9936

Larry Steckler, EHF, CET, CA
Gernsback Publications
500 Bi-County Blvd
Farmingdale, NY 11735
516-293-3000 X-201

Hubert West, CET, CA
20 Schuyler St
Lake George, NY 12845
518-668-9285
hwest789@concentric.net

Richard Mildenberger, CET, CA
Quaritius TV
147 Merrick Ave
Merrick, NY 11566
516-379-3970

Gary Rathbun, CET, CA
Cleveland Inst Of Elect
1776 E 17th St
Cleveland, OH 44114
216-781-9400
216-781-0331
instruct@cie-wc.edu

Richard Ackerman, CET, CA
3603 Steeplechase Ln #3d
Loveland, OH 45140-3246
W-513-573-4704
H-513-583-1402

Lawrence Delonais, CET, CA
NEC
1660 Martin Rd
Mogadore, OH 44260
330-923-9959

Joseph Carney, III, CET, CA
Malthus Diagnosis
35888 Center Ridge Rd
N Ridgeville, OH 44039
330-327-2585
330-327-7286
Joecarney@aol.com

Michael Beaver, CET, CA
Univ Of Rio Grande
School Of Technolgy
Rio Grande, OH 45674
740-245-7314
740-245-7440
mbeaver@urgrgcc.edu

A C Falcione, CET, CA
Falcon Elect Inc
3266 Kent Rd
Stow, OH 44224
330-688-2451
330-688-8747

Joe Harris, CA
Tulsa Tech Cntr
3850 N Peoria
Tulsa, OK 74106-1691
918-428-2261 X-264

Noah Harrelson, CAt, CA
Tulsa Tech Cntr
3850 N Peoria
Tulsa, OK 74106-1691
918-428-2261 X-241

Roy Yonce, CA
5103 S Sheridan Rd #214
Tulsa, OK 74145-7627

Vern Hartshorn, CET, CA
Mt Hood Comm College
26000 SE Stark St
Gresham, OR 97030
503-667-7117

VOLUNTEER CET EXAMINERS

James Shambow, CET, CA
ITTES
6035 NE 78th Ct
Portland, OR 97218-2854
503-255-6500
800-234-5488

Thomas Gaudiello, CET, CA
Chi Inst (RETS Campus)
W Chester Pike/Malin Rd
Broomal, PA 19008
610-353-7630
tomg@inet.net

L.A. Leibensperger, CET, CA
5225 Camp Meeting Rd
Center Vly, PA 18034
610-866-4114

William Margut, CA
Elect Inst
19 Jamesway Plaza
Middletown, PA 17057-4851
717-944-2731

Gene Hedgepeth, CET, CA, CMAT
Techtronics Svcs
2165 Alberdeen Rd
Moutaintop, PA 18707-9059
717-868-6566
717-821-0509
717-868-3444

Thomas Plant, CET, CA
ETG Of Rhode Isl
29 Dean St
Pawtucket, RI 02861
401-725-8719

Stanley Salter, CET, CA
Stan Salter Music Svc
826 Bay Blossom
Sumter, SC 29150
803-469-3022

Don Multerer, CET, CA
Sencore Inc
3200 Sencore Dr
Sioux Fls, SD 57107
605-339-0100
800-736-2673

Ronald Rackley, CET, CA
Tenn Inst Of Elect
3203 Tazewell Pike
Knoxville, TN 37918-2530
423-688-9422
423-688-2419

William Warren, CET, CSM, CA
Warren Elect Svc
2540 Sutherland Ave
Knoxville, TN 37919
423-546-1128
423-524-5362

John Weaver, CA
3334 Nonesuch Rd
Abilene, TX 79606-1924
915-698-5785
915-622-7091
jweaver@tstc.edu

Francis E Cave, CET, CA
6303 Lotus Dr
Arlington, TX 76001
817-468-8706
817-640-7100
cave@arlington.net

Fred Duck, CET, CA
Austin Comm College
1212 Rio Grande
Austin, TX 78701-1785
512-223-3044
512-247-5763
512-495-7400
Duck2021@juno.com

Alan Green, CET, CA
ITT Tech Inst
6330 Hwy 290 East
Austin, TX 78723-1061
512-467-6800

Henry Corrie, CET, CA
1460 CR 3413
Chandler, TX 75758
903-852-4140
903-593-0220

Tom Underwood, CET, CA
Tomtronics Inc
10424 Remington Ln
Dallas, TX 75229
214-357-0644
tomund@aol.com

Rodger W Minatra, CA
Grayson Cnty College
6101 Grayson Dr
Denison, TX 75020-8299
903-463-8670
903-463-5284
rminatra@grayson.edu

Robert Griffin, CET, CA
TCJC
5301 Campus Dr
Ft Worth, TX 76119
817-531-4529

Arthur Ruppert, CET, CA
30217 St Andrews
Georgetown, TX 78628
512-863-9157

James Harris, CET, CA
1505 Tanglewood Dr
Harker Hts, TX 76548
817-698-2331
817-526-1257
harrisj@hood-emh3.Army.MiL

Alden Walther, CA
ITT Tech Inst
2950 S Gessner Rd
Houston, TX 77063-3751
713-952-2294

Gordon Davis, CA
6934 Drowsy Pine
Houston, TX 77092
713-462-8764

Frank Ureno, CA
Texas A&M Univ-Kingsville
Box 122
Kingsville, TX 78363
512-593-2111
512-593-3605
fureno@tamuk.edu

Marlys A Hendershot, CA
1317 East Huisache
Kingsville, TX 78363
H-512-592-0853
W-512-592-3608

Gerald Martin, CET, CA
Lucent Technologies
107 W Nakoma
San Antonio, TX 78216
210-527-3347
210-527-3347
gimartin@lucent.com

Earl Hines, CET, CA
1710 Lamar Lot#2
Sweetwater, TX 79556
915-235-1849
915-235-7404
915-235-7369
ehines@selib.tstc.edu

Sandra Woodman, CA
TSTC
300 College Dr
Sweetwater, TX 79556
915-235-7406
800-592-8783

Dickie Lide, CET, CA
Texas State Tech College
3801 Campus Dr
Bldg 7-05
Waco, TX 76705
254-867-4883
254-867-3631

Sandra L Herinckx CET CA
Texas State Tech College
3801 Campus Dr Bldg 7-5
Waco, TX 76705
254-867-4883
254-867-3631
sherinck@tstc.edu

Dick Kimberley, CA
Salt Lake Comm College
4600 S Redwood Rd
Salt Lake Cty, UT 84130-0808
801-957-4235
801-280-9590
801-965-8008

Norman F Gresley, CET, CA
52 Hancock Pl NE
Leesburg, VA 22075
703-443-0185
540-347-8978

Charles Spiro, CET, CA
Lord Fairfax Comm College
Box 47
Middletown, VA 22645
540-869-1120
540-869-7881
cspiro@shentel.net

Ted Rodriquez, CET, CA
Skagit Vly College
2405 College Way
Mt Vernon, WA 98273
360-416-7757
360-416-7843
rodriquez@skagit.ctc.edu

Roberta Wells, CA
ITT Tech Inst
N 1050 Argonne Rd
Spokane, WA 99212
509-926-2900

Del Dressel, CET, CA
Oakland Radio & TV
3901 S Center St
Tacoma, WA 98409-3148
206-840-4975
206-840-5099

David Bates, CET, CA
Western Wi Tech College
304 N 6th St
Lacrosse, WI 54602
608-785-9290
608-785-9407
BatesD@western.tec.wi.us

Duane Busby, CET, CA
BC&D Ent
2027 Sherman Ave
Madison, WI 53704-5934
608-244-0339

Jeff Paschke, CET, CA
1011 Jefferson St
New London, WI 54961
414-982-3641
414-982-3641
JPASC5871@aol.com

Jacob Klein, CET, CA
Northcentral Tech College
1000 W Campus Ave
Wausau, WI 54401
715-675-3331 X-4395
715-675-4917

C Stephen Triplett, CA
NITC
5514 Big Tyler Rd
Cross Lanes, WV 25313
304-776-6290
304-776-6262

David L Woodruff,Jr
NITC
5514 Big Tyler Rd
Cross Lanes, WV 25313
304-776-6290

Egon Strauss, CET, CA
V. De Obligado 2376
Buenos Aires
Argentina 1428
541-781-8564
541-782-2088
egon@laufquen.com.ar

Richard M Hopkins CA
Napanee Dist School
245 Belleville Rd
Napanee, Ontario
Canada K7i 3M7
613-354-3381

Gary Memory, CET, CA
Amer Emby
Paris, France
PSC-116 Rm# A314
APO AE 09777
33-1-47.53.82.55
101365.1113@compuserve.com

Antonio M Avellanosa, CA
MPITI
45 Tecson St
Baguio City, Philippines 2600
74-442-8170
74-442-6532

Jose M T Bigornia, CA
c/o Cebu Tech Sch
Osmena Bw
Cebu City, Philippines 6000
(063-32) 2542434
(063-32)2538797
ctsinc@weblinq.com

Julius Bissessar, CET, CA
Quarry Vlg P.O.
Quarry Vlg-Via Siparia
Trinidad-Tobago,
West Indies
809-649-6127

was designed to measure the degree of theoretical knowledge and technical proficiency of practicing technicians. By acquiring the CET designation, a technician stands out in the electronics industry as being devoted to maintaining the professionalism required by the ever-changing electronics industry. What's more, in the ever-challenging but always demanding job market, a technician who is able to demonstrate his or her ability to perform a job with professional competence and skill has a decided advantage.

It is important to note that while the employment outlook for electronics technicians is strong, to ensure they are hiring experienced and competent workers, an increasing number of employers are now recruiting CETs to fill their servicing positions. What's more, major companies, manufacturers, service centers and educational institutions have come to expect individuals to continue to develop professionally.

It is clear that a strong national certification program is vital to the future of technicians. Proven skill standards and integrity in the development of exams and training programs has earned ISCET the well-deserved reputation as the leader in industry certification. ISCET also recognizes that a technician's need to stay current and proficient does not end with CET certification. That's why ISCET offers certification, training, continuing education, and peer support to those technicians who carry the CET designation. Thanks to ISCET's efforts, the CET program has become widely accepted by technicians, manufacturers, and consumers.

The Exams. There are two levels of ISCET certification: Associate and Journeyman. The Associate CET exam is intended for technicians with less than four years of training or education. It consists of 75 questions covering basic electronics, AC/DC circuits, basic math, transistors and semiconductors, electronic components, instruments, test and measurement, and troubleshooting.

(Continued on page 68)

BY DON LANCASTER

The Right Way to Measure AC Power

ACCURATE MEASUREMENT OF REAL-WORLD AC POWER HAS LONG BEEN THE BANE OF BEGINNING EE STUDENTS. THAT'S ESPECIALLY TRUE OF AC POWER IN THE PRESENCE OF PHASE SHIFTS, HARMONICS, AND NONLINEAR LOADS.

Power measurement difficulties also partly explain why "magic lamp" and other misinformed "free energy" pseudoscience scams still persist on the Web. It's also why you probably have not yet done your own careful home-power inventory to try and trim your personal power bill.

Thankfully, there's now bunches of new ways to accurately view and measure AC power. But before we look at these new happenings, let's go over some groundwork.

AC Power Fundamentals

Work is done any time you have any force actually move something through a distance. Energy is defined as the capacity for doing work. And power is the time rate of doing work. Electrical power is often measured in watts or kilowatts. Electrical energy is sold by the kilowatt hour. (One watt of power over one hour equals one watt hour of energy. A thousand watts for one hour—or one watt for a thousand hours—gives you one kilowatt hour of energy, for which you usually pay your power company a dime.)

Say you have a black box with two access terminals on it. First measure the instantaneous voltage across these terminals, then measure the instantaneous current that is going into one of the terminals. The instantaneous product of the voltage in volts and the current in amps should be your instantaneous power in watts.

If the current and voltage are both positive or are both negative, your instantaneous power is going into the black box. We say the black box acts as a load or a sink that is consuming power. Presumably, the input power is internally developing heat, moving something to where it does not want to go, emitting light, altering chemical states, building up some electric or magnetic field, or otherwise doing some sort of work.

On the other hand, if the terminal voltage is positive and your current is negative or vice versa, we'll say the black box is a generator or a source, which is now producing power. The generated power has to come from some other external energy source by diminishing the strength of any previously built up internal electrical or magnetic fields, through chemical conversion to lower energy states, or by some other means that strictly and absolutely conserves total energy, minus, of course, the irreversible fraction always lost as unrecoverable low-grade heat. Carnot always gets his cut.

NEED HELP?

Phone or write all your US Tech Musings questions to:

Don Lancaster
Synergetics
Box 809-EN
Thatcher AZ, 85552
Tel: 520-428-4073

US email: don@tinaja.com
Web page: http://www.tinaja.com

The tricky thing about AC "loads" is that they sometimes are a source of energy and sometimes are a sink of energy. Thus, power flow in typical real-world AC devices can be a two-way street: In and out.

Let's use Fig. 1 to see some of the problems that power waveforms can cause for us. In Fig. 1A we have an AC source driving a linear resistive load—a hot water heater, maybe. Input voltage (shown) and current (not shown) will both be sinewaves, and they will both be in-phase with each other. Your power waveform should always be positive and should vary at twice the frequency of the input voltage.

In Fig. 1B we drive a nonlinear resistive load—perhaps a hydrogen generator, or something else that might draw disproportionately more current at higher voltages. The current waveform will now involve harmonics. The power waveform is still always positive, and still varies at twice the input frequency. Only this time, the power waveshape peaks are a lot narrower.

In Fig. 1C we show the power waveform typical of a capacitor-input full-wave rectifier. Such a nonlinear switched load is common in many electronic power supplies. Power is only briefly drawn near the middle of each AC half cycle when the diodes conduct. In this case, the current and voltage are still technically in phase, but the current waveform has very strong and objectionable harmonics.

In Fig. 1D you will find the waveform typical of a lamp dimmer set to half brightness. No power at all is drawn for the first quarter cycle till the lamp is turned on by a Triac or a silicon-controlled rectifier. Such a waveform clearly is phase shifted and has strong harmon-

new from
DON LANCASTER

ACTIVE FILTER COOKBOOK
The sixteenth (!) printing of Don's bible on analog op-amp lowpass, bandpass, and highpass active filters. De-mystified instant designs. $28.50

RESEARCH INFOPACKS
Don's instant cash-and-carry flat rate consulting service. Ask any reasonable technical question for a detailed analysis and complete report. See www.tinaja.com/info01 for specifics. $75.00

CMOS AND TTL COOKBOOKS
Millions of copies in print worldwide. THE two books for digital integrated circuit fundamentals. About as hands-on as you can get. $28.50 each.

INCREDIBLE SECRET MONEY MACHINE II
Updated 2nd edition of Don's classic on setting up your own technical or craft venture. $18.50

LANCASTER CLASSICS LIBRARY
Don's best early stuff at a bargain price. Includes the CMOS Cookbook, The TTL Cookbook, Active Filter Cookbook, PostScript video, Case Against Patents, Incredible Secret Money Machine II, and Hardware Hacker II reprints. $119.50

LOTS OF OTHER GOODIES

Tech Musings V or VI	$24.50
Ask the Guru I or II or III	$24.50
Hardware Hacker II, III or IV	$24.50
Micro Cookbook I	$19.50
PostScript Beginner Stuff	$29.50
PostScript Show and Tell	$29.50
PostScript Video & secrets	$29.50
PostScript Reference II	$34.50
PostScript Tutorial/Cookbook	$22.50
PostScript by Example	$32.50
Understanding PS Programming	$29.50
PostScript: A Visual Approach	$22.50
PostScript Program Design	$24.50
Thinking in PostScript	$22.50
LaserWriter Reference	$19.50
Type 1 Font Format	$16.50
Acrobat Reference	$24.50
Whole works (all PostScript)	$380.00
Technical Insider Secrets	FREE

BOOK-ON-DEMAND PUB KIT
Ongoing details on Book-on-demand publishing, a new method of producing books only when and as ordered. Reprints, sources, samples. $39.50

THE CASE AGAINST PATENTS
For most individuals, patents are virtually certain to result in a net loss of sanity, energy, time, and money. This reprint set shows you Don's tested and proven real-world alternatives. 28.50

BLATANT OPPORTUNIST I
The reprints from all Don's Midnight Engineering columns. Includes a broad range of real world, proven coverage on small scale technical startup ventures. Stuff you can use right now. $24.50

RESOURCE BIN I
A complete collection of all Don's Nuts & Volts columns to date, including a new index and his master names and numbers list. $24.50

FREE SAMPLES
Check Don's Guru's Lair at *http://www.tinaja.com* for interactive catalogs and online samples of Don's unique products. Searchable reprints and reference resouces, too. Tech help, hot links to cool sites, consultants. email: *don@tinaja.com*
FREE US VOICE HELPLINE VISA/MC

SYNERGETICS
Box 809-EN
Thatcher, AZ 85552
(520) 428-4073

FREE catalog: http://www.tinaja.com

ics. In addition, the sharp leading edge is a possible source of radio interference.

In Fig. 1E we see the input to a pure (ideal) capacitor. The voltage and current waveforms will be phase shifted by precisely 90 degrees, with the current leading. There are times when the capacitor is accepting current and increasing its internal electric-field storage. There are times when the capacitor is producing current and decreasing its internal storage. The average long term power is zero!

Driving any pure inductor would again have the voltage and current waveforms shifted by precisely 90 degrees, only this time the voltage is leading. (This is easy for you to remember using the old but reliable mnemonic ELI the ICE man.) Once again, your current goes both ways, and the long-term power always averages to zero.

In Fig. 1F we view the super important case of a typical motor. Here we have a lagging load that is mostly resistive, combined with the inductance of the motor winding. A power factor can be defined as the cosine of the phase angle. A common power factor of 0.8 implies a phase shift of around 37 degrees. With such a lagging load, the current still goes both ways, except the dominant flow this time is into the motor. Note the two brief and lower power reversals in each line cycle.

I have purposely left the current waveforms out of Fig. 1 to keep things simple. I invite you to sketch all these in as an "exercise for the serious student" as there's lots to be learned here.

Summing up: In just about any reasonable AC device you can think of, the power waveform will be more or less nonlinear. Typically, you'll have a hard-to-measure average long-term value overlain by some cyclic double-frequency waveform. Thus, accurate AC power measurement all comes down to measurement of an arbitrary waveform that

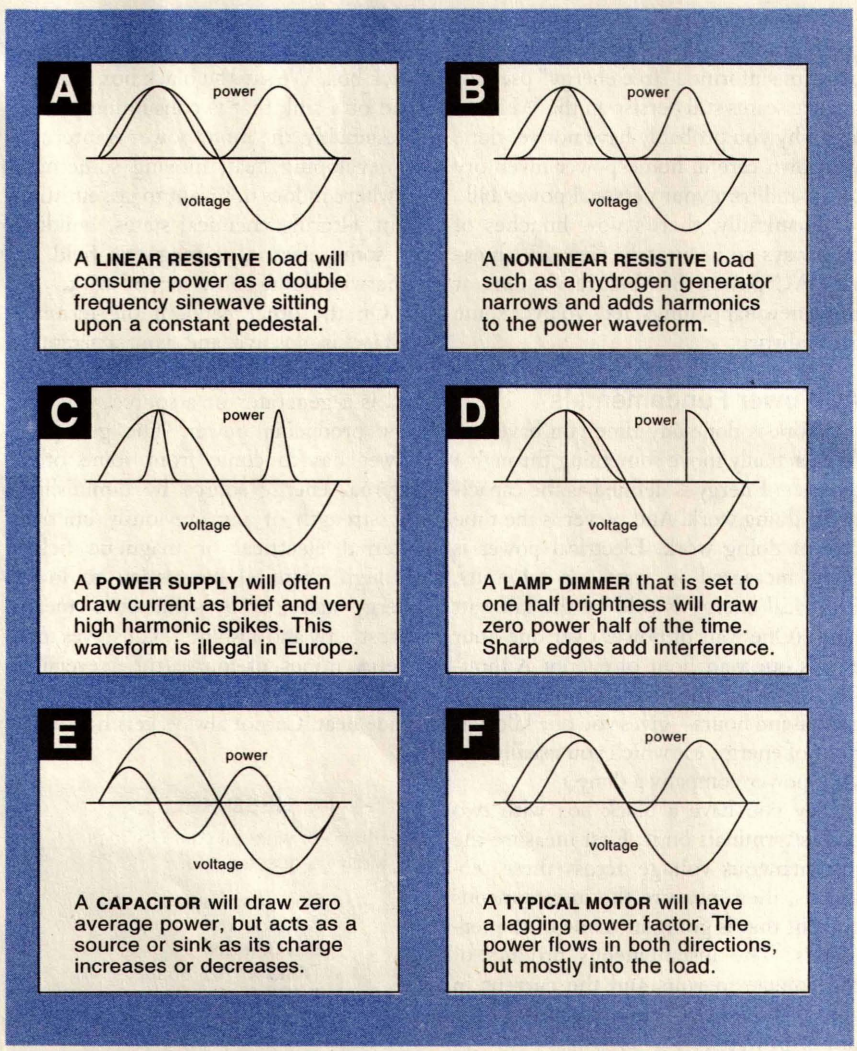

A
power
voltage
A LINEAR RESISTIVE load will consume power as a double frequency sinewave sitting upon a constant pedestal.
B
power
voltage
A NONLINEAR RESISTIVE load such as a hydrogen generator narrows and adds harmonics to the power waveform.
C
power
voltage
A POWER SUPPLY will often draw current as brief and very high harmonic spikes. This waveform is illegal in Europe.
D
power
voltage
A LAMP DIMMER that is set to one half brightness will draw zero power half of the time. Sharp edges add interference.
E
power
voltage
A CAPACITOR will draw zero average power, but acts as a source or sink as its charge increases or decreases.
F
power
voltage
A TYPICAL MOTOR will have a lagging power factor. The power flows in both directions, but mostly into the load.

FIG. 1—DUE TO THEIR UNUSUAL SHAPES, AC power waveforms have long been very difficult to accurately display and measure.

TO MEASURE POWER:

1. Low pass prefilter voltage and current waveforms so they do not change much in an 80 microsecond interval. Do this identically and sharply.
2. Starting with a zero crossing and a minimum of exactly 12,000 line locked times per second, accurately sample and record the voltage.
3. Accurately sample and record the current at precisely the same time the voltage is sampled.
4. Accurately multiply the sampled current times the sampled voltage. Sum these results. Make sure the multiplication accuracy and precision is consistent with the expected crest factors involved.
5. Repeat the measurement, multiplication, and summing exactly 12,000 times. Then divide the summed result by 12,000 to find the ac power consumed or delivered during that one second interval. The result will be both the power in watts and the consumed energy in watt seconds.
6. Multiply the watt seconds by 3600 to get the actual average energy consumption in kilowatt hours.

TO CALCULATE ELECTRICAL COSTS:

7. Add up the expected actual use hours per month, taking into account the on-off duty cycle and the exact number of days in the target month. Then multiply this times the kilowatt hours to get the kilowatt hours actually consumed for the chosen month.
8. Multiply the kilowatt hours used per month by the cost per kilowatt hour to find your monthly operating cost. Sum the monthly operating costs to get the yearly operating cost of the electricity used.

FIG. 2—ONE USEFUL METHOD to accurately measure AC power.

is formed by the product of two values. Thankfully, these days there is a relatively easy way to make any low-frequency measurement.

Do It Digitally

Figure 2 shows you a good way to accurately calculate AC power. While you could dream up an analog multiplier circuit, such devices will quickly get into some crest-factor problems. The crest factor is the ratio of your peak power to the average power. Analog solutions tend to get complex if the needed crest factor exceeds three or so. Dimmers (Fig. 1D) and rectifiers (Fig. 1C) often exceed that value.

Instead, the trick is to A/D convert the current and voltage waveforms, sampling them digitally at the same time, and then digitally multiply them together. How many samples do you need? I'd vote for at least 100 per half cycle, or 12,000 per second. That sounds high at first glance, but with the often-seen power waveforms of Fig. 1C, that would only leave you with ten or so non-zero samples per half cycle, and an accuracy at best of five percent.

Note that any power measurement scheme either has to measure one full cycle or else has to measure a "large number" of cycles. Otherwise errors are certain to happen when portions of cycles are unfairly or randomly represented. It does pay to lock your measurement scheme to the voltage or current zero-crossings such that whole cycles are always measured.

Strong lowpass filtering of both voltage and current waveforms is a good idea to reduce high-frequency noise. But it is super important that identical filters be applied to both voltage and current to prevent group delay problems.

The voltage and the current really should get measured at exactly the same time. But if your sample rate is high enough, you might get by just taking the average of two sequential current measurements. For instance:

#46—current
#47—voltage
#48—current
#49—voltage
#50—current

. . . and then multiply voltage #47 times the average of current #46 and current #48. Similarly, multiply voltage #49 times the average of current #48 and current #50, and so on.

A PIC is your obvious choice for lowest-cost AC power measurement calculations. Suitable current sensors might include a current transformer (Amecon is one better source), Hall-effect sensors, clamp probes, or measuring the voltage drop across a suitable small series resistor.

The New Stuff

As we already found out back in June, 1997 (MUSE112.PDF), those ordinary cheap voltmeters and ammeters are totally useless to measure real AC power. Such meters measure average rather than true rms. They all lie like a rug, because their "answer" is so highly waveshape dependent. Instead, here are several of the latest new developments in low-cost accurate AC power measurement:

True rms meters—The costs for digital or analog meters with a true rms ability is dropping dramatically. Even Radio Shack now resells $79 digital voltmeters that can provide true rms. A true rms meter gives you total waveform and full harmonic independence, as long as you stay under acceptable crest factors, which at least gets rid of the really stupid measurement mistakes. But note that since you don't know the phase angle, you still cannot multiply rms volts times rms amps to get power.

Digital storage scopes—The latest of DSOs and many computer data-acquisition plug-ins now permit you to multiply input values together and display the results, which lets you directly view those power waveforms of Fig. 1. Doing that was once horrendously difficult to do.

Analog Devices AD7750—This new chip family was originally intended as a $2.50 solid-state replacement for a European 50-hertz power meter. Inside you will find a pair of high-accuracy A/D converters, a digital multiplier, a digital-to-frequency converter, and even stepper motor drivers for a mechanical totalizer.

Some external filter parts seem to be required for 60-hertz operation. The output frequencies of only a few hertz are surprisingly low, so they seem best at averages rather than for cycle-by-cycle measurements.

Their data sheet does mention crest factors of two, which suggests that it may not do all that great on stranger waveforms. The European method around high crest factors is to simply make them illegal, which is what IEC standard 555-2 is all about and why there is so much excitement over those new power-factor correction chips and

circuits. Analog Devices Website is found at www.analog.com.

Maxim MAX125—This is a brand new simultaneous multi-channel A/D converter. It is specifically designed for power meters, motor controls, and for power-factor monitoring. There are eight analog inputs that are routed to a 4PDT selector switch and then input to four simultaneous A/D converters. Fourteen bit conversion is provided in three microseconds, by using the circuit of Fig. 3. An external clock is needed. Its typical value is 16 MHz.

There are fourteen parallel data outputs, the lower four of which are used as bi-directional address inputs to program one of eight conversions plus a power down. The choices are A or B sides of one through four channels of conversion. It takes three microseconds to do the one-channel conversion and twelve microseconds for a four-channel conversion.

There are four control inputs of chip select, read enable, write enable, and conversion start. There's also a "conversion-done" output normally used as an interrupt.

After conversion is done, the first read-enable reads out channel 1 as parallel data. The next one outputs channel 2, then channels 3 and 4 in order.

For single-phase power, you'd normally only select a single side of channel 1 for current and channel 2 for voltage. The full four channels may be required for three-phase power systems or exotic motor controls.

Note that this chip only measures the input values for you, doing so accurately and simultaneously. Your host PIC or whatever has to do the math to calculate actual instantaneous power.

The interface to a PIC or other microcontroller is fairly simple. An external data latch may be needed in some systems. Evaluation kits and free chip samples are available. Maxim's Website can be found at www.maxim-ic.com.

Digitest DT500—This is a unique home-power monitor that I've been testing. Using a $399 list package about the size of a box of cereal, you can monitor 120/240 volt AC appliances for the voltage, current, kilowatt hours, and duty cycle, plus actual electricity costs in dollars and cents.

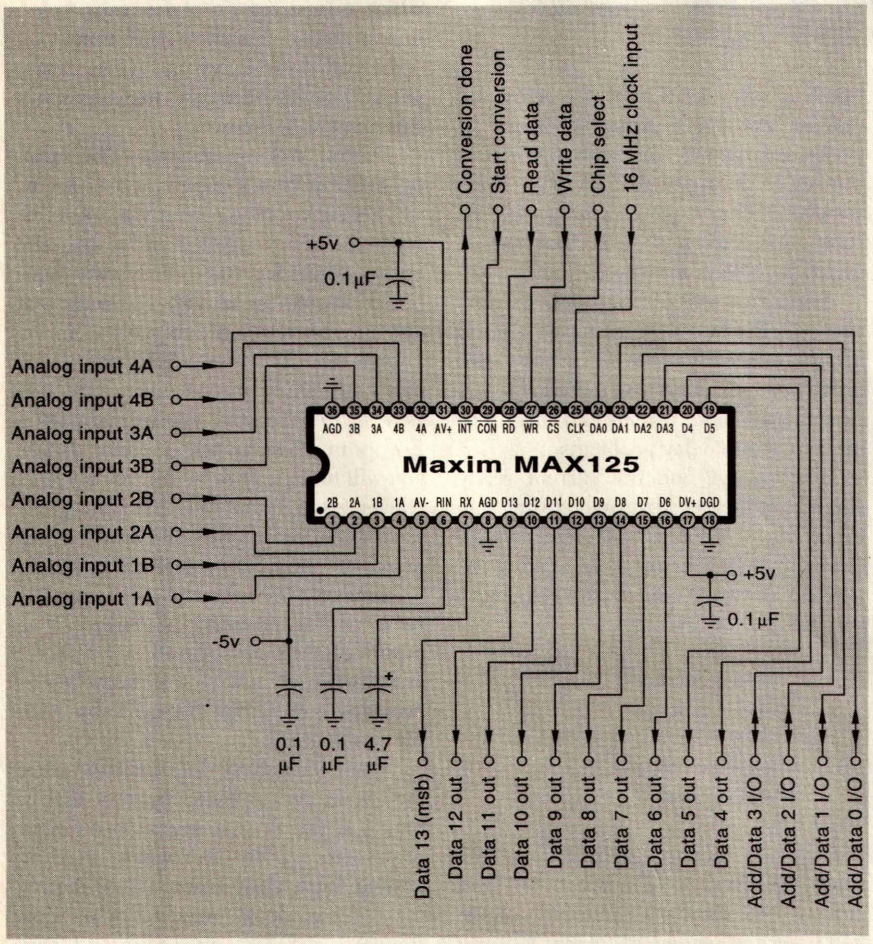


FIG. 3—THE NEW MAXIM MAX125 lets you simultaneously sample voltage and current. This is a crucial first step in digital power measurement. A microcontroller does the actual multiplication.

AC POWER-MANAGEMENT RESOURCES

Amecon
1900 Chris Ln.
Anaheim, CA 92805
(714) 634-2220

Circuit Cellar Ink
4 Park St. #20
Vernon, CT 06066
(203) 875-2751

Digitest Services
4518 Chateau Dr.
Albany, GA 31707
(912) 883-4047

EPRI Journal
PO Box 10412
Palo Alto, CA 94303
(415) 855-2000

Electronics Now
500 Bi-County Blvd.
Farmingdale, NY 11735
(516) 293-3000

Energy Depot
1797 Northeast Expressway #100
Atlanta, GA 30329
(404) 633-9099

Home Automator
2258 Sandy Lane
Mebane, NC 27302
(910) 578-9519

Home Power
PO Box 520
Ashland, OR 97520
(800) 707-6585

Maxim
120 San Gabriel Dr.
Sunnyvale, CA 94086
(800) 998-8800

Remote Measurement
2633 Eastlake Ave. #200
Seattle, WA 98102
(206) 328-2255
www.measure.com

Rocky Mountain Institute
1739 Snowmass Creek Rd.
Snowmass, CO 81654
(970) 927-3851

Zomeworks
PO Box 25805
Albuquerque, NM 87125
(505) 242-5354

The Four-Year Electronics Degree Program That Really Hits Home!

Bring The Technology Home With A Bachelor Of Electronics Engineering Degree. No Hassles. No High Cost!

Now's the time to prepare for a profitable career.

We've lowered the cost of higher education.

It's true! You can earn a four-year Bachelor of Electronics Engineering Technology degree today ... and prepare yourself for a high-paying electronics career ... without quitting your job or ever leaving your home. Because World College, an affiliate of the Cleveland Institute of Electronics, offers you the total flexibility of independent study programs proven effective for people like you who truly want to succeed! World College independent study lessons help you build valuable skills step-by-step, and expert instructors are personally available to you with a toll-free call. What a way to earn an education!

Mail/Fax Today or Call 1-800-696-7532

A world of opportunity.

Where is your career headed? With a four-year bachelor's degree from World College, you call the shots, choosing from incredible, high-paying opportunities in electronics, telecommunications, computer, electrical power, and many other growing fields.

World College gives you the skills, the knowledge, the power to take advantage of your best opportunity in electronics. And you can do it all at your own pace!

Without leaving home.

World College continually works to provide its students with the most advanced education tools. From the latest equipment and reference books to breakthrough computer-simulated experiments, students are exposed to the latest technological advancements.

All the equipment, parts, and software you need are included in your affordable tuition, including more than 300 hands-on lab experiments you can complete in your home.

Choose your own pace.

Earn your bachelor's degree on your time — and at your pace — because you pay tuition to World College only as you complete the upper-level semesters close to graduation. The faster you make it through, the less you pay. So you have an incentive to make your future happen quickly — yet the freedom to choose your own pace!

Send today for your FREE course catalog — and give yourself that future you've always wanted — with an electronics degree education from World College.

Take charge of your future in electronics.

Four Powerful Reasons To Connect With World College Today:

1. **Earn your four-year degree!**
2. **Self-paced training!**
3. **Independent study in your home!**
4. **Expert instruction!**

Give Me The Power!

Send me a FREE World College course catalog today!

(Please Print Neatly)

Name _____

Address _____

City _____

State, Zip _____

Phone ( ) _____

Age _____

For faster service, call 1-800-696-7532, or call 1-804-464-4600.

Or fax this coupon to 1-804-464-3687.

WORLD COLLEGE

Lake Shores Plaza
5193 Drive, Suite 113
Virginia Beach, VA 23455-2500

ICE

Affiliated with
Cleveland Institute of Electronics

WAE66

NAMES AND NUMBERS

Adobe Acrobat
1585 Charleston Rd.
Mountain View, CA 94039
(800) 833-6687

Card Technology
300 S Wacker Dr. 18th fl
Chicago, IL 60606
(312) 913-1334

Data Storage
10 Tara Blvd. 5th fl
Nashua, NH 03062
(603) 891-0123

Forming & Fabricating
One SME Dr.
Dearborn, MI 48128
(313) 271-1500

Klockit
PO Box 636
Lake Geneva, WI 53147
(800) 556-2548

Lindsay Publications
PO Box 538
Bradley, IL 60915
(815) 935-5353

Logic Devices
1320 Ocean Dr.
Sunnyvale, CA 94089
(408) 542-5400

Mabry Publishing
PO Box 31926
Seattle, WA 98103
(206) 634-1443

Magnet Applications
415 Sargon Way, Suite G
Horsham, PA 19044
(800) 437-8890

muRata-Erie
2200 Lake Park Dr.
Smyrna, GA 30080
(800) 731-9172

Precision Navigation
1235 Pear Ave. #111
Mountain View, CA 94043
(415) 962-8777

Roberts Electric
311 N Morgan St.
Chicago, IL 60607
(312) 829-1365

Science/AAAS
1333 H St. NW
Washington, DC 20005
(202) 326-6400

Surplus Direct
Box 2000
Hood River, OR 97031
(800) 753-7877

Synergetics
Box 809
Thatcher, AZ 85552
(520) 428-4073

Don Thompson Seminars
20650 Prairie St.
Chatsworth, CA 91311
(800) 423-5400 x2537

You can plug an appliance or other load into the back of the unit, use an accessory snap-around current probe, or directly input any custom test voltage that is related to current. You can very quickly find out that your refrigerator is costing you $19.37 per month, your freezer gobbles $9.78, and so on.

Around 3600 current and voltage samples per second are taken in this Intel 8751 based device.

The DT500 certainly does what it claims to, and sure is a lot of fun to play with, especially for doing your own home-energy inventory. On the other hand, the ergonometrics aren't all that great, the LCD desperately needs to be backlit, the cents per kWh cost entry is klutzy, and there's zero I/O provision for data capture, record keeping, or for any history plotting. In addition, some sort of a wireless current sensor with a 35-foot range sure would be handy.

The Remote Measurement Systems Power Sentry—This is a neat little infrared sensor that sticks to the glass of an ordinary power meter and then counts every time the black mark on the disk comes around. The $79 device is not only allowed by certain power companies, but it is actually approved of and strongly encouraged. A companion ADC-1 interface and control software for Mac or PC lets you plot a month's power use in half-second intervals.

I've gathered a few preliminary sources for AC-power measurement and home-energy management as this month's resource sidebar. More on rms power measurement in MUSE112.PDF on www.tinaja.com.

New Tech Lit

From Logic Devices there's a new *Power of Signal Processing* data book. In it, you will find special video-filter, alpha mixer-channel, and histogram chips. From muRata-Erie comes a new *RF and Microwave Products Catalog* in which you'll find bunches of ceramic resonator and surface acoustic wave (SAW) devices.

Texas Instruments has come out with a pair of new CD-ROM data books entitled *InfoNavigator* and *The Future of DSP Technology*. Also from TI are data sheets on their new low-cost TSL253 light-to-voltage converter.

An item on the use of DNA computing to solve a major math problem appears on pages 446-449 of *Science* for October 17, 1997. Volume 278.

A booklet on higher-performance permanent magnets is available from Magnet Applications. Some low-cost hygrometers are resold by Klockit. Hydraulic bargains can be found at Roberts. Superb laser-printer service seminars, and printer maintenance manuals are offered by Don Thompson.

Richard Grier has a new *Visual Basic Programmer's Guide to Serial Communications*, his useful text on low-level Windows communications access. It is published by Mabry. From Lindsay Publications comes two volumes of their "new-old" 1906 reprint "Experimental Science" series; those are *Elementary Practical Physics* and *Experimental Physics*.

Featured trade journals for this month are *Data Storage* for hard-disk insiders, *Forming & Fabricating* for sheet metal, and *Card Technology* on smart cards.

The latest and finest version of Adobe Acrobat is newly available for $49 from the Academic Software division of Surplus Direct. Acrobat includes the powerful Distiller 3.01 program which makes an outstanding host-based PostScript-as-language computer. More details on the power of raw PostScript computing can be found in DISTLANG.HTML and also in POSTFLUT.PDF on my Guru's Lair at www.tinaja.com.

For nearly all individuals and all small-scale startups most of the time, an involvement with patents is likely to end up as a net total loss of time, energy, money, and sanity. Find out why in my *The Case Against Patents* package per my nearby Synergetics ad.

Plus the usual reminder about my Guru's Lair Website at www.tinaja.com. Some of the latest additions include new information on virtual reality, surplus and auction details, and newly expanded Bezier cubic spline coverage.

As usual, most of the mentioned items should appear in our Names & Numbers or AC Power-Management Resources sidebars. Always check there first before calling our US technical helpline. EN

SUPPLEMENT TO ELECTRONICS NOW MAY 1998

Electronic SHOPPER®

MICRO SIZE CCD VIDEO CAMERAS

MB-750U
Video Camera
$99.95

MB-705UX
C-Mount Camera
with Lens Included;
8 or 12mm Lens
your choice!

LP-850i Lipstick Camera

LP-850i Excellent monitoring Camera, and ideal for CU-SeeMe. $249.95

Cost Effective Color Board Cameras
MB-1282 $199.95
with Built-In Audio out

Pinhole Versions Available

See More Products @ Polaris Industries
http://www.polarisusa.com

800.752.3571

Free Catalog

470 Armour Drive NE • Atlanta GA 30324 • Tech Info: 404-872-0722 • FAX 404-872-1038

TEST EQUIPMENT SALES

Looking for a **400 MHz 4 channel scope?** Why spend $8000 for a used TEK 2465B when you can buy a new Iwatsu SS-7840 for ***$6995 with a 3 year warranty !!!***

Also available is a replacement for the TEK 2467B. The Iwatsu TS-8500 boasts a 500 MHz bandwidth and ultra high writting speed for an unbelievable ***$11,995 with a 3 year warranty !!!*** Call for specs and/or details about these and other high end analog scopes.

P.O. BOX 986
LONDONDERRY, NH 03053

PHONE (800) 684-4651
FAX (603) 425-2945

Check out these items that just came in and are like brand new!

HP 6002A-001....200 WATT AUTORANGING DC POWER SUPPLY w/ HPIB.....$795
HP 3325A-002....SYNTH./FUNCTION GENERATOR w/ HIGH VOLTAGE OPT.....$1950
HP 59501B.....ISOLATED DAC / POWER SUPPLY PROGRAMMER.....$250
HP 6228B.....DUAL OUTPUT DC POWER SUPPLY 50 Volt 1 Amp.....$695
HP 5328B-010....UNIVERSAL COUNTER w/ HIGH STAB. TIME BASE.....$795

ASK ABOUT OUR NEW TEKTRONIX & FLUKE PRODUCTS

BLOWOUT! TIMELINE INC. BLOWOUT!

Over 11 years and 29,000 customers and still growing

LIQUID CRYSTAL DISPLAYS

240x64 dot LCD with built-in controller.
AND 4021ST-EO. *Unit is EL back-lit.* **$59.00 or 2 for $109.00** *or*
OPTREX. DMF5005 *(non back-lit)* **$49.00 or 2 for $89.00**
20 character x 8 line
7¾L x 2½H
The built-in controller allows you to do text and graphics.

Alphanumeric—parallel interface

16x1.....$7.00	20x2.....$10.00	32x2.....$8.00
16x1 (lg. char.)....$10.00	20x4.....$15.00	40x1.....$8.00
16x2.....$7.00	20x4 (lg. char.)....$10.00	40x2 .....2 for $20.00
16x2 (lg. char.)....$10.00	24x2.....$10.00	40x4.....$20.00
16x4.....$15.00	32x4.....$10.00	4x2.....$5.00

5V power required • Built-in C-MOS LCD driver & controller • Easy "microprocessor" interface • 98 ASCII character generator • ***Certain models are backlit, call for more info.***

Graphics and alphanumeric—serial interface

size	Mfr.	price	size	Mfr.	price
640x480 (backlit)	Epson	$25.00	480x128	Hitachi	$10.00
640x400 (backlit)	Panasonic	$20.00	256x128	Epson	$20.00
640x200	Toshiba	$15.00	240x128 (backlit)	Optrex	$20.00
480x128 (backlit)	ALPS	$10.00	240x64	Epson	$15.00
			160x128	Optrex	$15.00

6" VGA LCD 640X480, Sanyo LMDK55-22 **$25.00**

LASER PRODUCTS

HeNe Laser Head (10Mw max. output) TEMOO, 15.5" long MFG: NEC **$89.00**
Laser Power Supply (for HeNe tube) **$79.00**

LASER SCANNER ASSEMBLY $19.00
Assembly intended for a laser printer. Includes laser diode, polygon motor (6 sided) and misc. optics and lenses.

LASER DIODE (5mW) with collimator **$20.00**

VISIBLE LASER DIODE: 5mw at 670nm **$15.00**
Index guided. Threshold current 40 ma typical.

3 and 4mW, 1,300nm LASER DIODES, 5.6mm package, $15.00
Mitsubishi Electric part number ML701BIR-E21A, General specs are:
1. Vop=1.25, Beam Divergence 25.6° x 28.6°; 2. Tc=24°C, Iop=19 to 20mA, ITH=10.7mA; 3. Wavelength range between 1,280nm and 1,330 nm

POLYGON MOTOR UNIT & DRIVER $69.00
Ten-sided first surface mirror mounted on an armature that spins at 125 revolutions per second yielding a beam sweep rate of 1250 sweeps per second. The driver for the polygon unit requires 24 volts and plus and minus 12 volts to operate. There is also an f-theta lens in front of the polygon scanning mechanism with a three inch diameter. Great for optical experiments, etc. Very high quality units. (MFR: JAPAN ELECTRONICS)

POS & BAR CODE

MAGNETIC CARD READER $25.00
Includes: • 20 character dot matrix display with full alpha-numeric capability • keypanel with full alpha-numeric entry • separate 7.5 VDC/0.5 Amp power supply • standard telephone interface extension cord • lithium battery and flat-cone speaker.

HP bar code wand (HBCS 2300).....$25.00

POWER SUPPLYS

SWITCHING POWER SUPPLYS $12.00 or 2 for $20.00 115/230 Volts
73 WATT (2) 4 pin power connectors attached • Dim: 8.5" L x 4.5" W x 2" H
Output: +5V @ 2-9.75, A, +12V @ 0-1.5 A, -5V @ 0-0.4 A, -12V @ 0-0.5 A
60 WATT Dim: 8¾ x 4¼ x 3 • Output:5V @ 6A + 12V @ 1A - 5V @ 1A - 12V @ 1A

CHARGE COUPLED DEVICES

"The Spy In The Sky" $29.00 **MATRIX TYPE**

Thomson 576X550 pixel CCD
400-1,100nm resolution and responsivity. **$500.00 Original cost device**

Sony CCD Imager - designed for black and white composite video cameras. Picture elements: 384 (H) x 491 (V) $29.00
Chip size 10.7 (H) x 9.3 (V) mm² • Unit cell size 23.0 (H) x 13.4 (V) um².
Ceramic 24 pin DIP package • Mfr: Sony, Part# 016AL

4096 element CCD $15.00
1024 element CCD $10.00 **LINEAR TYPE**
2048 element CCD $10.00 • 1728 element CCD $10.00

MISCELLANEOUS

ADAPTEC 4070A (RLL) OR 4000A (MFM), SCSI Controller, your choice $25.00

IBM 370 option XT and AT emulation boards $25.00

MONITORS

Non-Enclosed TTL
Comes with pinout. 12V at 1.4 Amp input • Horizontal frequency 15Khz. • Ability to do 40 and 80 column.
5 inch Amber $25.00 • 7 inch Amber $25.00
9 inch Amber or Green $25.00

5" COLOR MONITOR $39.00
2 for $69.00
• Flat Faceplate • 320 x 200 Dot Resolution • CGA & Hercules Compatible
• 12 VDC Operation • 15.75 KHz Horiz. Freq. • 60 Hz Vert. Sync. Freq.
• Open Frame Construction • Standard Interface Connector • Degaussing Coil included • *Mfr. Samtron*

9" COLOR SVGA MONITOR $249.00
Fully Enclosed – Tilt and swivel type.

HACKER CORNER

EMBEDDED 486 COMPUTER $99.00
Complete enhanced Intel 486SX-33 based computer in ultra small (9-7/8L x 6-5/8W x 3-1/8H) case. Ideal for embedded operations or as a second computer. Features include: • One 16 bit ISA slot • 3 serial ports plus dedicated printer port • Parallel optical coupled adapter port • Built in IBM PC/AT keyboard port • On board VGA video and port • Uses standard SIMM up to 32 MB • BIOS is PC/AT compatible
Unit has a backup Ni-Cd battery system in case of power failure (5 min. backup time) and lockable front cover to prevent floppy drive access. Mounting / interface provisions for standard 3.5" laptop floppy and 2.5 inch hard drives. Comes with very comprehensive manual.

Encased Spread Spectrum RF Modem $199.00
The ProxLink Radio Module is a small communication device which replaces cables between RS-232 devices with wireless RF (Radio Frequency) technology. Attaching a pair of ProxLinks to any two devices with three wire asynchronous RS-232 ports allows wireless data transmittal at rates up to 19.2 Kbaud (full duplex) over a range of 500 - 800 feet. Modules use 900 MZ spread spectrum radio for communication which does not require an FCC site license. A variety of configuration information (radio channel, baud rate, serial port configuration, etc.) can be programmed into module's non-volatile memory by host PC to provide compatibility and avoid overlapping systems. Configuration changes are supported by menu driven, on-board software. Commonly used Terminal Emulation software and transfer protocols can be used for configuring modules and transferring data between computers. ProxLinks require only 6-9 VDC (350 mA), RS-232 (9 pin sub - D) interface, and small (~ 4") whip antenna for operation. Unit size is 4.0" x 6.5" x 0.75". Installation schematics and application details available.

US made Micronics 486 VLB ALL in ONE $39.00 or 2 for $69.00
motherboard, supports 3.4 or 5V CPU, at either 25 or 33 mhz basic clock. Can use AMD or Intel from 486SX25 thru 486DX4-100 to HOT new AMD 5X86-133 cpu. On board SVGA video. On board 1 meg video ram expandable to 2 meg with ATI Mach 2 chip set. On board 2 high speed serial ports, 1 printer port, floppy and IDE hard drive controller. On board 256K cache. Uses 72 pin simm memory. Landmark speed rating of 479 with AMD chip.
Board will not fit standard All in One case because of non standard location of riser board. VLB riser board is included with motherboard.

COLOR CCD CAMERA $149.00
• 12 VDC • 1/3-inch, CCD area image sensor • 514 (horizontal) x 491 (vertical) • 2:1 interlaced • 15.734 kHz (horizontal), 59.94 Hz (vertical) • 330 horizontal and 350 vertical lines • 10 Ix • 1V, NTSC signal format • Lens: 1/3-inch, fixed focus (F:2.8 f:5.6) • Dimensions: (W) 67 (2.63) x (H) 34 (1.45) x (D) 112.6 (4.43)

SONY Miniature Color LCD Display (LCX005BKB) $29.00
• 1.4 CM (0.55 inch) Diagonal Full Color Display • Built In Horizontal and Vertical Drivers • Delta Dot Pattern for High Picture Quality - 537 dots (H) x 222 dots (V) • Compatible with NTSC & PAL Format and Sync Inputs • 12 VDC Operation with -1 to +17 V RGB Signal and Driver Input Voltage • Excellent Display for Virtual Reality Projects, Viewfinders, and Miniature Test Equipment Displays • Pin Outs and Specification Included • Unit Requires Clock, Synchronization and Video

CELL SITE TRANSCEIVER $49.00 2 for $89.00
These transceivers were designed for operation in an AMPS (Advanced Mobile Phone Service) cell site. The 20 MHz bandwidth of the transceiver allows it to operate on all 666 channels allocated. The transmit channels are 870.030-889.980 MHz with the receive channels 45 HMz below those frequencies. A digital synthesizer is utilized to generate the selected frequency. Each unit contains two independent receivers to demodulate voice and data with a Receive Signal Strength Indicator (RSSI) circuit to select the one with the best signal strength. The transmitter provides a 1.5 watt modulated signal to drive an external power amplifier. channel selection is accomplished with a 10 bit binary input via a connector on the back panel. Other interface requirements for operation are 26 VDC (unregulated) and an 18.990 MHz reference frequency for the digital synthesizer. The units contain independent boards for receivers, exciter, synthesizer, tunable front end, and interface assembly (which includes power supplies and voltage-controlled oscillator). Service manual, schematics and circuit descriptions included.

Encased Black & White Composite CCD Camera with Adapter
IR viewing to 1000 nm 7 ½ L x 2 ¾ W x 1 ¾ H
Comes complete with CCD camera, mounting nut on bottom of casing, 12VDC power supply. Excellent low light capability, standard RCA NTSC video out. **$89.00**
Great for: entryway security/remote monitoring, video conferencing/desktop video conferencing **2 for $159.00**
This miniature camera is perfect for multimedia computer applications as well as security and surveillance. NTSC output allows use with all popular video digitizing boards for Apple Macintosh and Microsoft video for Windows. Connects directly to any composite monitor or VCR with "video" input. Its razor-sharp wide-angle lens focuses from two inches to infinity and its state-of-the-art CCD technology accurately captures 16 level grayscale images for Quick Time movies and still pictures. Records at 30 frames per second and 260 lines resolution with excellent low light capability. Uses 12VDC (adapter supplied) and standard RCA cable.

2539 W. 237th Street, Bldg. F, Torrance, CA 90505
Order desk only: **USA: (800) 872-8878 CA: (800) 223-9977**
L.A. & Technical Info: **(310) 784-5488** Fax: **(310) 784-7590**
OEM INQUIRIES WELCOME

Minimum Order: $20.00. Minimum shipping and handling charge $5.00. We accept cashiers checks, MC or VISA. No personal checks or COD's. CA residents add 8.25% sales tax. We are not responsible for typographical errors. All merchandise subject to prior sale. Phone orders welcome. Foreign orders require special handling. Prices subject to change without notice. 20% restocking fee for returned orders.

CIRCLE 275 ON FREE INFORMATION CARD

CIRCLE 270 ON FREE INFORMATION CARD

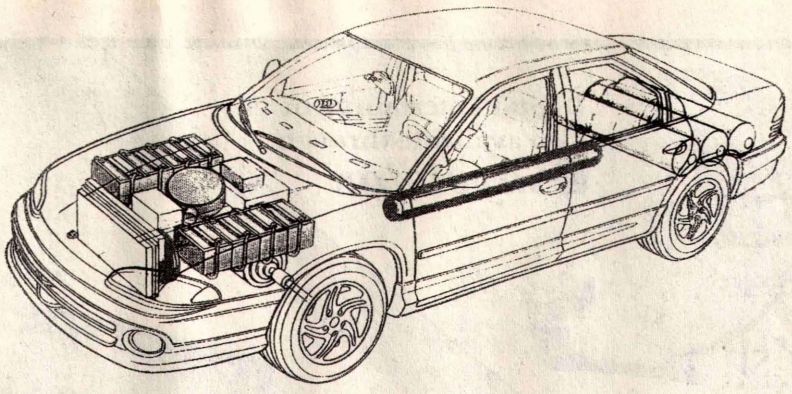
FUEL-CELL VEHICLES

(continued from page 53)

cient fuel for a very respectable 250-mile range. Mercedes-Benz has said it plans to produce 100,000 fuel-cell powered A-Class cars by 2005.

Not only smaller and more efficient, the new reformer process gives improved performance and dynamic response. According to Mercedes-Benz, when you press the throttle, 90% percent of the power is available in two seconds. That puts fuel-cell vehicles on a par with conventional gasoline- or diesel-powered automobiles. The NECAR 3 is virtually emission-free. Neither nitrogen oxides nor soot particles are produced during the reformulation process or in the fuel cell itself.

In Japan, Mazda has demonstrated a 20-kW PEM fuel-cell engine and Toyota unveiled its first fuel-cell vehicle with a 20-kW PEM system in 1996 with a second-generation version planned for this year. Honda is also working on a fuel-cell vehicle. Renault, in collaboration with Volvo, is working on its FEVER (Fuel Cell Vehicle of Extended Range). Reportedly, BMW, Nissan, Volkswagen, Siemens, Toshiba, and others have fuel-cell projects on the drawing board.



Hydrogen would be stored on-board in the Chrysler-Pentastar direct-hydrogen PEM Fuel-Cell Program vehicle. The PEM fuel-cell system would replace the internal combustion engine. (Fuel Cells 2000)

Will you see a fuel-cell car down at your local dealer soon, or even within a few years? Probably not. Besides bugs still to be worked out, there is the matter of cost. Fuel cells are still many times more expensive than the most sophisticated and powerful dual-overhead camshaft, 48-valve V-12 running on ordinary gasoline. Also, automakers are understandably reluctant to cast aside their huge investment in the internal-combustion engine for a new technology that would require another huge investment for new manufacturing facilities and whose consumer acceptance is still an unknown quantity. Still, fuel-cell technology might just represent the best current option to replace the internal-combustion engine. Ω

NATIONAL TECHNICIAN'S DAY

(continued from page 56)

To qualify for Journeyman certification, a technician must have four years or more of education and/or experience in electronics. He or she must also have passed the Associate CET exam and must take and pass a 75-question Journeyman Option exam on one of several areas of specialization. Those areas include: Audio, Biomedical, Communications, Computers, Consumer Products, Industrial, Radar, Video, and Appliance Servicing. A technician may also use the Associate certification issued by the Electronics Technicians Association International (ETA) to qualify for any of the Journeyman options.

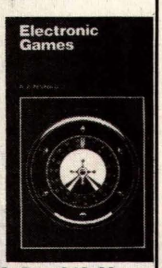
If you have already attained Journeyman certification, you can take one of several 25-question Endorsement exams designed to prove advanced expertise in a specific field. Currently, Endorsement exams are available in Camera/Camcorder/8mm, Computer Monitor, Motor Control, VCR, Audio, CD/VLD, and Digital Communications.

The fee structure is as follows: For the Associate exam, the fee is $30. For any Journeyman Option, the fee is $35. If both the Associate and a Journeyman Option exam are taken at the same time, the fee is $50. Each test has a two-hour time limit, and a score of 75% or better is required to pass. For the Journeyman Endorsement exam, the fee is $35, there is a one-hour time limit, and a 75% score is required to pass the exam.

ISCET test examiners are also qualified to administer FCC element tests. The fees vary depending on which elements are taken.

To Commemorate T-DAY. ISCET invites all technicians to celebrate National Electronics Technicians Day during the Week of April 21 through April 25, 1998, which has been designated T-WEEK. If you are planning to take the CET exams, now is the time as during T-WEEK, ISCET's network of Certified Test Administrators will be providing opportunities for interested technicians to obtain their certification. Whether you are interested in completing your Associate, Journeyman , or Journeyman Endorsement Certificate; gaining continuing education units; or want to sit for one of many FCC elements, contact one the examiners in the Volunteer Examiners box that accompanies this article. Those test administrators are dedicated to the continued growth of the CET program and anxiously await hearing from you. For more information on the CET program, visit ISCET's home page located at www.iscet.org. Ω

ELECTRONIC GAMES



BP69—A number of interesting electronic game projects using IC's are presented. Includes 19 different projects ranging from a simple coin flipper, to a competitive reaction game, to electronic roulette, a combination lock game, a game timer and more. To order BP69 send **$8.00 (includes s&h)** in the US and Canada to **Electronic Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240.** US funds only. Use US bank check or International Money Order. Allow 6-8 weeks for delivery. MA07

Mark V Electronics, Inc.
8019 E. Slauson Ave.,
Montebello, CA 90640
Catalog 213/ 888-8988
Fax 213/ 888-6868
http://www.mark5co.com
Email: mark5co@aol.com

DIY Audio Electronic Kits
Lab Equipment kits
Audio Enclosures & more!

ORDER
1-800-521-MARK
1-800-423-FIVE

Kit skill levels
▲ Beginner
▲▲ Intermediate
▲▲▲ Advanced

- Fast Shipping
- Quality Kits low prices
- In business since 1985

Clearance Sale — FM Wireless Microphone

Kit ~~$ 12.50~~ 6.99

This is a low power real FM transmitter. Transmit frequency within 88-108 MHz. Transmit range about 200 ft. It has high sensitivity sound pickup by a capacitance microphone. May be used strictly for series purposes such as remote wireless monitering.

20 Color LED Level Meter

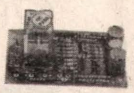
Clearance Sale

Kit ~~$ 20.15~~ 9.99

Use this dual LED display indicating meter with your stereo power amplifier to indicate instantaneous speaker power. Operating range is -30dB to +5dB and can be calibrated to operate with 1 to 200 W amplifiers. Not consume any amplifier power. A peak LED illuminates on overload!

Stereo Loudspeaker Protector

TY-25 ▲



Kit: $ 16.75

Super fast acting relay protects speakers against destructive DC voltages. Can connect directly to a power amplifier or can use a separate power supply. Has a 3 second turn-on delay to avoid turn-on thumps.

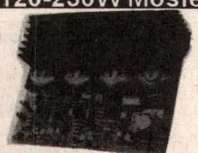
Regulated DC Power Supply

TR-503 ▲▲

Kit: $ 18.75

It is short circuit proof & has overload protection. Output voltage is variable over a range of 0-50 volts. Current limit trip is adjustable up to max of 3A. May use Mark V #002 transformer.

120-250W Mosfet Power Mono Amplifier AF-2 (6 lbs.) ▲▲



Kit: $ ~~89.80~~ 80.82 Asmb.$ 114.80

Power Output: 250W into 4 ohms RMS(42VX2 6A transformer is used). 120W into 4 ohms RMS(33VX2 4A transformer is used). Frequency Response: 3Hz-22,000Hz. THD: <0.03%. Signal to Noise Ratio: 91dB. Sensitivity: 1V RMS at 47k. Load Impedance: 4 or 8 ohms. Power Requirement: ±46VDC 4A or ±60VDC 6A. May use Mark V model 012 Transformer. Suggested Capacitor 8,200uf 100V Model 020. Suggested Metal Cabinet LG-1925.

300W High Power Mono Amplifier TA-3600 (5 lbs.) ▲▲▲

80.10
Kit ~~89.00~~
Asmb.$ 115.00

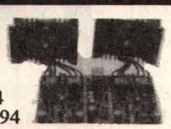
Power Output: 300W into 8 ohms RMS. 540W music power into 8 ohms. Frequency Response: 10Hz-20KHz. THD: < 0.05%. Sensitivity: 1V RMS at 47K. Power Requirement: 60 to 75 VDC at 8A. May use Mark V Model 007 or 009 Transformer. Suggested Capacitor: 8,200uf 100V Model 020 Capacitor. Suggested Metal Cabinet LG-1925.

120W + 120W Pre & Main Stereo Amplifier TA-800MK2 (4 lbs.) ▲▲

Kit: $ 67.92 Asmb.$ 86.95

Power Output: 120W into 4 ohms RMS. 72W into 8 ohms RMS. Frequency Response: 10 - 20 KHZ. THD: < 0.01%. Tone Control: Bass ±12dB, Mid ±8dB, Treble ±8dB. Sensitivity: Phono Input, 3mV into 47K. Line, 0.3V into 47K. Signal to Noise Ratio: 86dB. Power Requirement: 40V DC @ 6A. May use Mark V Model 001 or 008 Transformer. Suggested Metal Cabinet Model LG-1924.

80W + 80W Pure DC Stereo Main Power Amplifier TA-802 (4 lbs.) ▲▲



Kit: $ 49.94
Asmb.$ 69.94

Power Output: 80W per channel into 8 ohms. THD: < 0.05%. Frequency Response: DC to 200 KHZ, -0 dB, -3dB @ 1W. Power Requirement: 30V AC X 2 @ 6A. May use Mark V Model 001 or 008 Transformer. Suggested Capacitor 8,200uf 50V Model 017. Suggested Metal Cabinet LG-1924

30W + 30W Pre & Main Stereo Amplifier TA-323A (1 lb.) ▲

Kit: $ 32.50 Asmb.$ 50.50

Power Output: 30W into 8 ohms RMS per channel. THD: < 0.1% from 100 HZ to 10 KHZ. Sensitivity: Phono 3mV @ 47K. Tuner, Tape 130mV @47K. Signal to Noise ratio: 80dB. Power Requirement: 22 to 36V AC, 3A. May use Mark V Model 002 Transformer. Suggested Cabinet LG-1684.

Metal Cabinets
Aluminum Front Panel

LG-1273	3x12x7"	(4 lbs.)	$ 26.50
LG-1684	4x16x8"	(7 lbs.)	32.50
LG-1924	4x19x11½"	(10 lbs.)	38.25
LG-1925	5x19x11½"	(10 lbs.)	42.00
LG-1983	2¼x19x8"	(7 lbs.)	35.25

Transformers (5-12 lbs.)
**Toroidal Transformers

# 001	28V/30V x2	6A	$ 30.00
# 002	36V x2	3A	25.00
# 003	40V x2	6A	32.00
# 008**	28V/30V x2	6A	42.00
# 009**	48/53V x2	8A	68.00
# 012**	33/40/42V x2	6A	52.00

Minimum order: $ 20.00. We accept Visa, MasterCard, Money Orders, and Checks(allow 2 weeks for clearance). We ship by UPS ground inside US (min $6.00) and ship by US mail outside US. Please call our operator for orders over 2 lbs. or foreign orders.

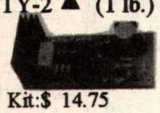
SCHOOL PROJECT CORNER
po orders welcomed from schools

Melody Generator	▲	Kit	$ 13.85
6W Mini-Amplifier	▲		9.50
0-15V 5A Regulated DC PS	▲		17.50
36W Class A Power Amp.	▲▲		32.50
Dynamic Noise Reduction	▲		26.00
Multi-Function Control Switch	▲		10.50
20 Bar/Dot Level Display	▲▲		41.45
Microphone Mixer Mono Amp.	▲		20.79
Superior Electronic Roulette	▲		21.50
Digital Clock with Melody Alarm	▲		25.00
Stereo Pre-Amp with Mic Amp.	▲		10.78
Mini Stereo Multi-Input Amp.	▲		30.50
130-in-one Electronic Lab	▲		29.99

SEE OUR CATALOG FOR MORE KITS !

Fluorescent Light Driver

TY-2 ▲ (1 lb.)



Kit:$ 14.75

This unit drives 6-40 watts fluorescent light for portable and emergency use. Works from a 7.2 - 16 VDC battery. Includes a "Hi-Efficiency Switching Mode IC Driving Circuit" suitable for use with different lights.

30-in-one Electronic Lab Kit ▲

KA-901 ~~$ 15.99~~ 12.99

No soldering is required! This simple electronics kit safely teaches the fundamentals of electronics. Build a radio, alarm, timer and more. Earphone for private listening. Uses safe battery power. Requires 4 "AA" batteries!

150MHz 8 Digit Frequency Counter

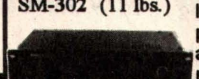
SM-100 (2 lbs.)

Kit:$ ~~79.00~~ 68.00
Asmb.$ 99.00

It is used for adjustment, test & repair of any kind of high frequency circuit products.It can give up to 8 digit of resolution for a wide frequency range 10Hz - 150 MHz. The last input frequency can HOLD on the display for future reference & comparison. The circuit structure is compact & reliable for the most updated A/D LSI circuitry. The input impedance is 1M ohm.

60+60W Stereo Power Amp. ▲▲

SM-302 (11 lbs.)



Kit:$ 85.00

It provides 3 input jack pairs. One pair accept a high impedance micro-phone. The two remaining pairs are for high & low level input sources. Power Output: 60W per channel into 4 ohms RMS. 20Hz-20KHz. THD:<0.1%. Input Sensitivity :Mic /Guitar 10mV, Hi 380mV, Lo 640mV.Ready to plug in when assembled.

300-in-one Electronic Lab Kit ▲▲

Best Buy

~~$ 59.99~~ 49.99

Learn about transistors, capacitors & electronic circuits. Build electronic games, battery checker & more. It even includes a breadboard for adding your own components. Complete with easy-to-follow manuel. Requires 6 "AA" batteries. (6 lbs.)

CIRCLE 326 ON FREE INFORMATION CARD

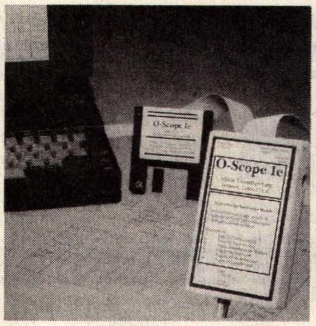
DIGITAL STORAGE

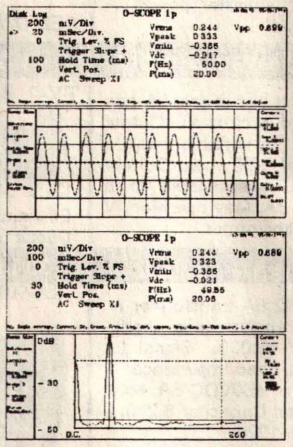
OSCILLOSCOPES

WITH SPECTRUM ANALYZER, DVM, FREQ. COUNTER, AND DATA LOGGER.

from **$189.**

PORTABLE MODULES CONVERT PC'S INTO MULTIPURPOSE TEST AND MEASURING INSTRUMENTS.





MasterCard VISA AMERICAN EXPRESS

Why lug a scope around? Toss one of our modules into your laptop case or tool kit. For a multi-purpose test device, plug to a PC parallel port and use the PC screen. Continuous, delayed, or triggered sweeps can be frozen on the screen, printed out, or saved to disk. Frequency Spectrums DC to 25 MHz.

Allison now provides PICO TECHNOLOGY Ltd. portable test equipment, including high-speed scopes, and multi channel data loggers. Pico and O-Scope modules accept standard probes and work with 286 or faster PC's.

FEATURES:

- PORTABLE UNITS TO 25 MHz
- USES PRINTER PORT
- USES STD. PROBES

OPTIONS:

- PROBE SETS
- AUTOMOTIVE PROBES
- BATTERY PACKS
- SOFT & HARD CASES

O-Scopes Made in U.S.A. **Picos Made in U.K.**
Same Day Shipping
Includes Cable, Software & Manuals

O-Scope Ip (DC-50KHz, single trace) .....$189.
O-Scope II (DC-500KHz, dual trace) .....$349.
PICO (ADC 200/20) (DC-10MHz, dual trace) .....CALL
PICO (ADC 200/50) (DC-25MHz, dual trace) .....CALL

PICO pc based data loggers from $99.

Shipping within U.S. UPS Ground $7.50(Second day $11.50)

SEND CREDIT CARD INFO., M.O., or CHECK,OR CALL

1-800-980-9806

Allison Technology Corporation

8343 CARVEL, HOUSTON, TX. 77036 U.S.A.
PHONE: 713-777-0401 FAX: 713-777-4746 BBS: 713-777-4753

http://www.atcweb.com

BOSSMAN ELECTRONICS

WE ARE IN THE YEAR 2000 OLYMPIC CITY SYDNEY IN AUSTRALIA,
PH:011 61 2 95843562, Fax:011 61 2 95843561, All prices US$. Typical Insured Air Mail: $10-$20, PAYMENT BY MAJOR CREDIT CARDS ONLY

CCD CAMERA $65 Low light high resolution CCD camera, two versions, NTSC (US) or PAL (European) compatible $65

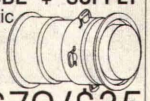
IR ILLUMINATOR KITS: 10 LED $9, 30 LED $20

FM TRANSMITTER Self contained, tunable, powered by a single LR44/G13 1.5V battery, 15g, 1.3" X 0.9" X 0.4". $30

TWO CHANNEL UHF REMOTE CONTROL On US frequency of 318MHz, transmitter is assembled, receiver is a kit, includes two 12V/12A relays, 1Tx + 1Rx kit:$35, additional Tx: $12 $35

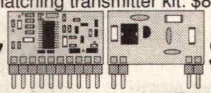
TIME LAPSE RECORDING INTERFACE KIT, Has relay outputs to switch VCR or connect via a remote control:$25 An alarm system output can be used to trigger record / stop. Unit automatically times out without movement. **PIR modules for:$10**

NIGHT VISION TUBE + SUPPLY Used 25mm fiber optic tube plus an EHT power supply kit to suit. With no blemishes or with small side blemish. $70/$35



UHF DATA TRANSMISSION Stamp sized Xtal locked 433.9MHz superhetrodyne receiver module $27 Small matching transmitter kit: $8

$27 $8



LASER TUBES US made 2-4mW He-Ne Laser head plus a potted (110V-220V) power supply to suit. $70

Complete 5mW-650nM Laser pointer kit: $15 Complete 10mW-640nM Laser pointer kit: $48 Ready made 5mW-650nM Laser pointer: $22 **Ready made 5mW-650nM Laser module**:$21 $15

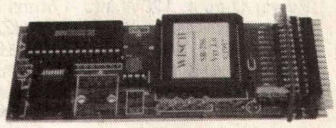
MORE KITS- DUAL STEPPER MOTOR DRIVER KIT with optoisolation, with two used motors & software: $40...**DOG SILENCER KIT** includes Piezo Tweeter: $25...**ALCOHOL BREATH TESTER KIT:** $30...**GEIGER COUNTER KIT:** $30...**BUG SIZED FM TRANSMITTER KIT:** $9...**LASER BEAM COMMUNICATOR KIT:** Tx-Rx + IR or Visible Laser: $39...**20A-DC MOTOR SPEED CONTROLLER** uses TI494 IC + PR mosfet, efficient switching design: $15...**TWO MOTOR AUDIO LASER SCANNER KIT** makes wild patterns:$35

THIS IS JUST A SAMPLER OF THE PRODUCTS ON SALE AT

www/world.net/~bossman

EPROM Emulator

Sockit Rockit



$99.00* Emulates: 27C256 27C128 27C64

The SR256 EPROM Emulator can emulate 8K x 8 to 32K x 8 120 ns EPROMs, with features that provide embedded code developers increased productivity. Advantages include: software selectable device size and target address; download verify; Hex, S-Record and binary file support; status LED; dual polarity reset outputs and single device bus loading.

INCLUDES

- PC Software and Quick Start Manual
- Table Assembler supporting common 8-bit micros
- PC Parallel Port Adapter and 7 ft. Interface Cable
- Reset Jumper Wire

**Shipping and handling not included.*
VISA, MasterCard, Discover and AmEx accepted.

Wisch Communications

2550 Trinity Mills Road
Suite 132B
Carrollton, TX 75006

Ph: (972) 417-3533
Fax: (972) 417-3821
wischcom@cyberramp.net

Synthesized FM Stereo Transmitter

Microprocessor controlled for easy frequency programming using DIP switches, no drift, your signal is rock solid all the time - just like the commercial stations. Audio quality is excellent, connect to the line output of any CD player, tape deck or mike mixer and you're on-the-air. Foreign buyers will appreciate the high power output capability of the FM-25; many Caribbean folks use a single FM-25 to cover the whole island! New, improved, clean and hum-free runs on either 12 VDC or 120 VAC. Kit comes complete with case set, whip antenna, 120 VAC power adapter - easy one evening assembly.

FM-25, Synthesized FM Stereo Transmitter Kit $129.95

Tunable FM Stereo Transmitter

A lower cost alternative to our high performance transmitters. Offers great value, tunable over the 88-108 MHz FM broadcast band, plenty of power and our manual goes into great detail outlining aspects of antennas, transmitting range and the FCC rules and regulations. Connects to any cassette deck, CD player or mixer and you're on-the-air, you'll be amazed at the exceptional audio quality! Runs on internal 9V battery or external power from 5 to 15 VDC, or optional 120 VAC adapter. Add our matching case and whip antenna set for a nice finished look.

FM-10A, Tunable FM Stereo Transmitter Kit. $34.95
CFM, Matching Case and Antenna Set. $14.95

RF Power Booster Amplifier

Add some serious muscle to your signal, boost power up to 1 watt over a frequency range of 100 KHz to over 1000 MHz! Use as a lab amp for signal generators, plus many foreign users employ the LPA-1 to boost the power of their FM Stereo transmitters, providing radio service through an entire town. Power required: 12 to 15 volts DC at 250mA, gain of 38dB at 10 MHz, 10 dB at 1000 MHz. For a neat, professionally finished look, add the optional matching case set.

LPA-1, Power Booster Amplifier Kit $39.95
CLPA, Matching Case Set for LPA-1 Kit. $14.95
LPA-1WT, Fully Wired LPA-1 with Case $99.95

Micro FM Wireless Mike

World's smallest FM transmitter. Size of a sugar cube! Uses SMT (Surface Mount Technology) devices and mini electret condenser microphone, even the battery is included. We give you two complete sets of SMT parts to allow for any errors or mishaps-build it carefully and you've got extra SMT parts to build another! Audio quality and pick-up is unbelievable, transmission range up to 300 feet, tunable to anywhere in standard FM band 88 to108 MHz. 7/8"w x 3/8"h x 3/4"h.

FM-5 Micro FM Wireless Mike Kit $19.95

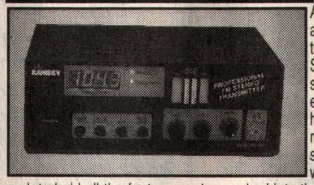
Crystal Controlled Wireless Mike

Super stable, drift free, not affected by temperature, metal or your body! Frequency is set by a crystal in the 2 meter Ham band of 146.535 MHz, easily picked up on any scanner radio or 2 meter rig. Changing the crystal to put frequency anywhere in the 140 to 160 MHz range-crystals cost only five or six dollars. Sensitive electret condensor mike picks up whispers anywhere in a room and transmit up to 1/4 mile. Powered by 3 volt Lithium or pair of watch batteries which are included. Uses the latest in SMT surface mount parts and we even include a few extras in case you sneeze and loose a part!

FM-6, Crystal Controlled FM Wireless Mike Kit $39.95
FM-6WT Fully Wired FM-6 ..... $69.95

RAMSEY

Super Pro FM Stereo Radio Transmitter



A truly professional frequency synthesized FM Stereo transmitter station in one easy to use, handsome cabinet. Most radio stations require a whole equipment rack to hold all the features we've packed into the FM-100. Set frequency easily with the Up/Down freq buttons and the big LED digital display. Plus there's input low pass filtering that gives great sound no matter what the source (no more squeals or swishing sounds from cheap CD player inputs!) Peak limiters for maximum 'punch' in your audio - without over modulation, LED bargraph meters for easy setting of audio levels and a built-in mixer with mike and line level inputs. Churches, drive-ins, schools and colleges find the FM-100 to be the answer to their transmitting needs, you will too. No one offers all these features at this price! Kit includes cabinet, whip antenna and 120 VAC supply.

We also offer a high power export version of the FM-100 that's fully assembled with one watt of RF power, for miles of program coverage. The export version can only be shipped outside the USA, or within the US if accompanied by a signed statement that the unit will be exported.

FM-100, Professional FM Stereo Transmitter Kit $299.95
FM-100WT, Fully Wired High Power FM-100. ..... $429.95

AM Band Radio Transmitter

Ramsey AM radio transmitters operate in the standard AM broadcast band and are easily set to any clear channel in your area. Our AM-25, 'pro' version, fully synthesized transmitter features easy frequency setting DIP switches for stable, no-drift frequency control, while being jumper setable for higher power output where regulations allow. The entry-level AM-1 uses a tunable transmit oscillator and runs the maximum 100 milliwatts of power. No FCC license is required, expected range is up to 1/4 mile depending upon antenna and conditions. Transmitters accept standard line-level inputs from tape decks, CD players or mike mixers, and run on 12 volts DC. The Pro AM-25 comes complete with AC power adapter, matching case set and bottom loaded wire antenna. Our entry-level AM-1 has an available matching case and knob set for a finished, professional look.

AM-25 Professional AM Transmitter Kit. $129.95
AM-1 Entry level AM Radio Transmitter Kit. $29.95
Cam Matching Case Set for AM-1. ..... $14.95

Tone-Grabber Touch Tone Decoder / Reader

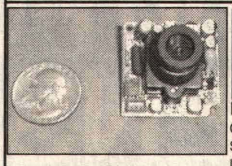
Dialed phone numbers, repeater codes, control codes, anywhere touch-tones are used, your TG-1 will decode and store any number it hears. A simple hook-up to any radio speaker or phone line is all that is required, and since the TG-1 uses a central office quality decoder and microprocessor, it will decode digits at virtually any speed! A 256 digit non-volatile memory stores numbers for 100 years - even with the power turned off, and an 8 digit LED display allows you to scroll through anywhere in memory. To make it easy to pick out numbers and codes, a dash is inserted between any group or set of numbers that were decoded more than 2 seconds apart. The TG-1 runs from any 7 to 15 volt DC power source and is both voltage regulated and crystal controlled for the ultimate in stability. For stand-alone use add our matching case set for a clean, professionally finished project. We have a TG-1 connected up here at the Ramsey factory on the FM radio. It's fun to see the phone numbers that are dialed on the morning radio show! Although the TG-1 requires less than an evening to assemble (and is fun to build, too!), we offer the TG-1 fully wired and tested in matching case for a special price.

TG-1, Tone Grabber Kit. $99.95
CTG, Matching Case Set for TG-1 Kit. $14.95
TG-1WT, Fully Wired Tone Grabber with Case $149.95
AC12-5, 12 Volt DC Wall Plug Adapter $9.95

The Cube World's Smallest TV Transmitter

Perfect video transmission from a transmitter you can hide under a quarter and only as thick as a stack of four pennies- that's a nickel in the picture! Transmits color or B&W up to 150' to any TV tuned to cable channel 59 with a solid 20 mW of power. Crystal controlled for no frequency drift with performance that equals law enforcement models that cost hundreds more! Deluxe model includes sound using a sensitive built-in mike that will hear a whisper 15 feet away! Units run on 9 volts and hook-up to most any CCD camera. Our cameras shown below have been tested to mate perfectly with The Cube and work great. Fully assembled.

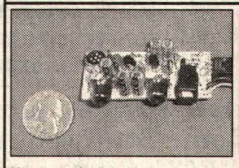
C-2000 Video Transmitter Cube. $89.95
C-3000 Video and Audio Transmitter Cube. $149.95



CCD Video Cameras

If you're looking for a good quality CCD board camera, stop right here! Our cameras use top quality Japanese Class 'A' CCD arrays, not the off-spec arrays that are found on many other cameras. You see, the Japanese suppliers grade the CCDs at manufacture and some manufacturers end up with the off-grade chips due to either cost constraints or lack of buying 'clout'. These cameras have nice clean fields and excellent light sensitivity, you'll really see the difference, and if you want to see in the dark, these are super IR (Infra-Red) sensitive! Available with Wide-angle (80°) or super slim Pin-hole style lens. Both run on 9 VDC and produce standard 1 volt p-p video. Add one of our transmitter units for wireless transmission to any TV set, or add our Interface board (below) for Audio sound pick-up and direct wire connection to any Video monitor or TV video/audio input jacks. Fully assembled.

CCDWA-2 CCD Camera, wide-angle lens. $99.95
CCDPH-2 CCD Camera, slim fit pin-hole lens. $99.95
IR-1 IR Illuminator Kit. $24.95



CCD Camera Interface Board

Here's a nifty little kit that eases hook-up of your CCD camera module to any video monitor, VCR or video input TV set. The board provides a voltage regulated and filtered source to power the camera (CCD Cameras require a stable source of power for best operation), sensitive electret condensor mike for great sound pick-up and RCA Phono jacks for both audio and video outputs. Runs on 11 - 20 VDC.

IB-1 Interface Board Kit. $14.95

Call for our Free Catalog !

RAMSEY ELECTRONICS, INC.
793 Canning Parkway
Victor, NY 14564

Order Toll-free: 1-800-446-2295
Sorry, no tech info or order status at this number

Technical Info, Order Status
Call Factory direct: (716) 924-4560
www.ramseyelectronics.com

VISA MasterCard DISCOVER

ORDERING INFO: Satisfaction Guaranteed. Examine for 10 days, if not pleased, return in original form for refund. Add $6.95 for shipping, handling and insurance. Orders under $20, add $3.00. NY residents add 7% sales tax. Sorry, no CODs. Foreign orders, add 20% for surface mail or use credit card and specify shipping method.

CIRCLE 266 ON FREE INFORMATION CARD

EARN MORE MONEY!

Be an FCC LICENSED ELECTRONIC TECHNICIAN!

No costly school. No commuting to class. The Original Home-Study course prepares you for the "FCC Commercial Radiotelephone License." This valuable license is your professional "ticket" to thousands of exciting jobs in Communications, Radio-TV, Microwave, Maritime, Radar, Avionics and more...even start your own business! You don't need a college degree to qualify, but you do need an FCC License.

No Need to Quit Your Job or Go To School

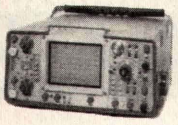
This proven course is easy, fast and low cost! GUARANTEED PASS—You get your FCC License or money refunded. **Send for FREE facts now. MAIL COUPON TODAY!**

Or, Call 1-800-932-4268 Ext. 210

COMMAND PRODUCTIONS
FCC LICENSE TRAINING, Dept. 210
P.O. Box 2824, San Francisco, CA 94126
Please rush FREE details immediately!

NAME _____
ADDRESS _____
CITY _____ STATE _____ ZIP _____

TEKTRONIX 465M SCOPE



AN/USM-425 militarized DC-100 MHz dual-trace oscilloscope with 8x10 CM display. Deflection 5 mv to 5 V/div in 10 calibrated steps, 1-2-5 sequence + vernier. Modes: TRIG View, 20 MHz BW, CH 1, ALT, Add, Chop, CH 2 or X-Y. Sweep 0.05 usec - 0.5 s/div in 22 steps + vernier; delay 0.05 us - 50 ms/div. Also X10 magnifier, adjustable handle, cover & manual coy. 100-132/200-264 VAC 48-440 Hz; 7x1.7x21.5, 32 lbs. **USED-CHECKED, $475.00**

O-135 VDC 15 A Supply

PP-1459A BATTERY CHARGER, used to charge storage batteries; produces unregulated 0-135 VDC 15 amp output from 115/230 VAC 50-60 Hz 15 amp input. Has 2.5" dia meters 0-150 VDC and 0-20 amps DC, Coarse & Fine 12-step controls, plus 115/230 V input selector. Input - Output each have circuit breaker; with power cord. 12x11x12, 60 lbs sh. **Used, $49.50**

Lifting Body Balloon

Distress-orange inflatable "manta ray" shaped balloon measures about 8 feet nose-to-tall, wing-tip-to-wing-tip; 3 feet at thickest. Intended to be helium-filled to raise a wire antenna for air-sea rescue transmitter. Slight breeze lifts it much easier than round balloon even when air-filled. Nice experimental; 3 lbs sh. **#SEB-42-ALV, unused, $25.00**

ANTENNA TETHER WIRE

306 FOOT SPOOL of vinyl-covered braided #22-size antenna wire intended for use with above kite or with balloon; usable as long wire antenna also. On spool; 3 lbs sh. **#SEB-400X3, unused, $12.95**

Prices F.O.B. Lima, Ohio. VISA, MASTERCARD Accepted.
Allow for shipping charges. Write for latest Catalog.
Address Dept. ES • Phone 419/227-6573 • Fax 419/227-1313
E-Mail: fairadio@wcoil.com Home Page: http://alpha.wcoil.com/~fairadio/

FAIR RADIO SALES
Box 1105 • LIMA, OHIO • 45802

LASERS

AT GREAT PRICES

Complete Ruby Laser Assembly less than $300
He-Ne Lasers, complete, for less than $50
American 60X Argon Lasers from $595
Laser Diode Modules from under $40
X-Y Scanners from $79

FREE CATALOG

- Helium-Neon
- Argon Lasers
- Diode Lasers
- Holography
- Books
- Ruby Lasers
- Scanners
- Lightshow Equipment
- Pointers
- Optics

Email: mlp@nlenx.com http://www.midwest-laser.com

Midwest Laser Products 30 Day Satisfaction Guarantee.
P.O. Box 262, Frankfort, IL 60423 VISA / MC Accepted
Phone: (815) 464-0085 FAX: (815) 464-0767

ALFA ELECTRONICS, INC.

- HIGH QUALITY TEST EQUIPMENT PROVIDER

1-800-526-2532 (526-ALFA)

15 Days Money Back Guarantee!

DMM

DMM-89S ($179.00): true rms, AC/DC (V,A), Ω, bar graph, freq, capac., dBm, logic, diode

DMM-88S ($149.00): AC/DC (V,A), Ω, bar graph, freq, capac., logic, diode

DMM-20 ($74.95): AC/DC (V, A), Freq, cont., Capac, Induct., Ω, hFE, diode, duty cycle

DMM-22 ($89.95): 4000counts, bar graph, Freq, AC/DC(V,A), Ω, Capacitance, diode, contin.

DMM-23T ($99.95): 4½ digit, true rms, high resol. (10μV, 10nA, 10mΩ), hFE, diode, contin.

DMM-10 ($19.95): 3½ digit, DC/AC V, Ω, hFE, diode, signal output(+3V,-0.5Vsq.,50%duty)

DMM-113 ($24.95): Pocket Size, DC/ACV, Ω, diode, Continuity beeper

DMM-120 ($24.95): economy type, DCV,ACV, DCA, Ω, hFE, diode

DMM-122 ($59.95): DC/AC(V,A), Ω, hFE, diode, capacitance, freq, logic, continuity

DMM-123 ($44.95): DMM + capacitance, DC/AC(V,A), Ω, hFE, diode, continuity

DMM-124 ($69.95): Electrical+Temp,DC/ACV, Ω, capacitance, freq, 3 phase, diode, contin.

DMM-125C ($54.95): Autorange + bar graph, DC/ACV, Cap,Ω, diode, continuity beeper

LCR METER

CAP-15 *($49.95)*: 3½ digit, 0.1pF-20mF, 9 Ranges, 0.1pF resolution zero adjustment.

LCR-24 *($139.95)*: 0.1μH-200H, 0.1pF-2000μF, 0.01Ω-20MΩ, diode test. ***New Model.***

LCR-814 *($189.95)*: 0.1μH-200H, 0.1pF-20mF, 1mΩ-20M Ω, Q Factor, dissipation, zero adjust

LCR-131D *($229.95)*: autorange, 0.1μH-10kH, 0.1pF-10mF, 1mΩ-10MΩ, Q Factor, serial/parallel, 120Hz/1kHz testing mode.

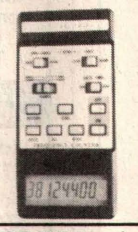
FREQ. COUNTER

FC-1200 *($129.95)*: 1.25GHz Handheld, 8 digits display, 10ppm accurary, sensitivity 5mV (130-350MHz), 30mV (440MHz), 22mV (800MHz), batteries or 9V adapter.

FC-2500 *($179.95)*: 2.5GHz Handheld, 8 digits display, 4ppm accurary, sensitivity <50mV, batteries or 9V adapter.

FC-5270A *($149.95)* 1.2 GHz bench type, 8 digit, 10 ppm, 35mV sensitivity, 10Vp-p max. input, power by 9V adapter.

FC-5700 *($329.95)* 1.3GHz bench type, 8 digit, 1 ppm accuracy, 20mV sensitivity, period 0.1μs to 100ms. Ideal for test & repair of audio instrument.



FLUKE DMM

HandHeld		*Scope Meter*	
12B	$ 84.95	**92B-III**	$1,445
70-III	$ 85.00	**96B-III**	$1,695
73-III	$115.00	**99B-III**	$2,095
75-III	$139.00	**105B**	$2,495
77-III	$154.00	**123-III**	$945
79-III	$175.00	**863E**	$475
87	$289.00	**867B**	$650
87-III	$309.00		

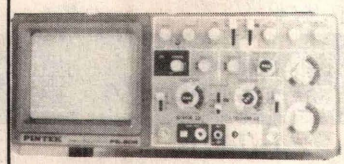
SPECIALITY METERS

- Sound meter $169.95
- EMF Tester $69.95
- Conductivity $169.95
- Thermometer $69.95-$89.95
- Humid./Temp meter $169.95
- Press. meter $299.95
- Electr. scale $89.95
- Watt Meter $129.95
- High Voltgae Probe $59.95
- pH Meter $79.95
- Light Meter $80-$90
- Light Adapter $49.95
- Anemometer $179.95
- Anemometer adapter (And More) $89.95

OSCILLOSCOPE

Dual Trace, Component Test, 6" CRT, X-Y Operation, TV Sync, CH2 Output, Graticule Illum, 2 Probes(x1;x10)

- PS-200 20 MHz Dual Trace $339.95
- PS-205 20 MHz Dual w/ Delay Sweep $429.95
- PS-400 40 MHz Dual Trace $494.95
- PS-405 40 MHz Dual w/ Delay Sweep $569.95
- PS-605 60 MHz Dual w/ Delay Sweep $769.95
- PS-1000 100MHz Dual Trace $999.95



Digital Scope:

- DS-303 30MHz Digital, 20 Samples/sec $849.95
- DS-303P RS-232 interface, 30MHz $1,049.95

Scope Probe:

HP-9060 (60MHz) $15, HP-9150 (150MHz) $22, HP-9250 (250MHz)$29, HP-9258 (250MHz,100:1)$39

AUDIO/RF/FUNCT. GENERATOR

RF Generator

- **SG-4160** ($124.95) 100kHz-150MHz sinewaves in 8 ranges, 100mV at 35MHz
- **SG-4162** ($229.95): same as SG-4160, plus 6 digits int/ext freq. counter (150MHz).

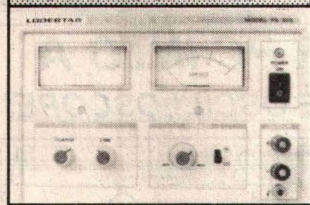
Audio Generator

- **AG-2601** ($124.95)10Hz-1MHz, 0-8Vpp sine, 0-10Vpp squarewave
- **AG-2603** ($229.95): same as AG-2601, plus 6 digits int/ext freq. counter (150MHz).

Function Generator

- **FG-2100A**($169.95).2Hz-2MHz,5mV-20Vpp
- **FG-2102AD** ($229.95) same as FG-2100A, plus int. counter and TTL, CMOS output.
- **FG-2103** ($329.95) *Sweep* 0.5Hz-5MHz, linear/log, VCG, GCV, 6 dig. int/ext counter

POWER SUPPLIES



Single Output DC Power Supplies

- Short Circuit and overload protected
- Constant current, constant voltage mode
- 0.02%+2mV line regulation; 0.02%+2mV load regulate

Analog Meters Display

PS-303 ($159.00) 30V/3A
PS-305 ($219.95) 30V/5A
PS-8110 ($289.95) 60V/3A
PS-8112 ($399.95) 60V/5A
PS-1610 ($289.00) 16V/10A
PS-8107 ($399.95) 30V/10A

Digital Voltage, Analog Current

PS-8200 ($179.95) 30V/3A
PS-8201 ($239.95) 30V/5A

Digital Volt & Current Display

PS-8300 ($199.95) 30V/3A
PS-8301 ($259.95) 30V/5A

Dual Tracking

- Short Circuit & overload protected
- Constant current & voltage mode
- Independent or Tracking

Dual Tracking (Analog V & I Displays)

PS-303D ($314.95) 30V/3A/30V/3A
PS-305D ($399.95) 30V/5A/30V/5A
PS-8108 ($549.95) 60V/3A/60V/3A
PS-8109 ($699.95) 60V/5A/60V/5A

Triple Output

- One fixed 5VDC, 3 Amp output
- Parallel to double current output (PS-8102 & PS-8103 only)

Triple Output (Analog displays)

PS-8102 ($399.95) 30V/3A/30V/3A
PS-8103 ($489.95) 30V/5A/30V/5A

Digital Displays

PS-8202 ($499.95) 30V/3A/30V/3A
PS-8203 ($549.95) 30V/5A/30V/5A

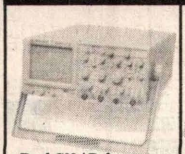
GW/INSTEK® Test & Measuring Instrument

ISO 9002 Cert. #934163 (2 Years Warranty)

OSCILLOSCOPE

OS-658G $849.95 50MHz Curs or Readout

OS-622G $369.95 20 MHz Oscilloscope



- Dual CH / Delay sweep
- **Readout & Cursor meas**
- Built-in delay line
- Z-axis input,CH1 output
- TV syn., trigger level lock
- 2 probes (x1, x10)

- Dual CH/X-Y operation
- 1 mV/div sensitivity
- Z-axis input,CH1 output
- TV syn., trigger level lock
- 2 probes (x1, x10)

OS-305 ($229.95) - 5 MHz One Channel
OS-310 ($324.95) - 10 MHz One Channel

Auto-set Cursor Read-out Oscilloscope

100 MHz OS-6102 **NEW** ***$1349.95***

- Dual channels
- **Auto-set** for parameter selection
- Automatic Peak to Peak
- Memory for 10 user-defined settings
- **RS-232** Remote control
- Triggering DC~250 MHz
- Alternate trigger
- Component tester

DC POWER SUPPLIES

Triple Output

- 2 variable out 0-30V,0-3A
- One fixed 5V,3A output
- Auto track, serial, parallel
- Const. volt, current mode
- 4 analog or 2 digital display

PC-3030 ($499.95)
PC-3030D ($549.95)

Single Output

- Const voltage, current mode
- Voltage regulation ≤0.01%
- Current regulation ≤0.2%
- PS: 2 analog or 1 digital disp
- PR: 2 analog or 2 digital disp

Analog Meters Display

PS-1830 ($209.95) 18V/3A
PS-1850 ($229.95) 18V/5A
PS-3030 ($219.95) 30V/3A
PS-6010 ($209.95)60V/10A
PR-3060 ($329.95)30V/6A
PR-6030 ($329.95)60V/3A
PR-1810H($349.95)18V/10A

Digital Meters Display

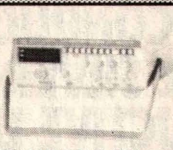
PS-1830D($229.95)18V/3A
PS-1850D($254.95)18V/5A
PS-3030D($254.95)30V/3A
PR-6030D($399.95)60V/3A

Programmable

- High stability, low drift
- One fixed 5V,3A output
- 100point program(PPS ser)
- 50point program(PPT ser.)
- Auto serial/parall.(PPT ser)
- Auto track (PPT series), IEEE-488.2 and SCPI compatible command set (optional)

PPS-1860G ($1,149.95)
PPS-3635G ($1,149.95)
PPS-6020G ($1,149.95)
PPT-1830G ($1,499.95)
PPT-3615G ($1,499.95)

FUNCTION GENERATOR



FG-8015G($179.95)Sweep
- 0.02Hz-2MHz,no counter
- Sine/Squ/Tri/pulse/Ramp

FG-8016G ($239.95)
- 0.02Hz-2MHz w/ counter
- Pulse, function generator

FG-8017G($249.95)Sweep
- Sine/Tri/Squ/TTL/CMOS
- 0.02Hz-2MHz, FM mod.

FG-8019 ($399.95) Sweep
- 0.02Hz-2MHz w/counter
- INT/EXT AM/FM mod

FG-8020G ($209.95)
- 0.02Hz-2MHz

FG-8050 ($499.95) Sweep
- 0.05Hz-5MHz w/counter
- INT/EXT AM/FM mod

FG-830G ($1,799.95) 30MHz Synthesized Function Gen.
- Output: sine, tri., square, sync out, arb. waveform
- 20mHz Freq. resolution
- Linear/log sweep
- Arbitrary modulation
- RS232; IEEE-488(option)

BENCHTOP DMM

DM-8034($179.95) 3½ dgt
- AC/DV(V,A),C,Ω,diode
- 1000V, 20A, 0.5% accu.

DM-8040($339.95) 3¾ dgt
- ACV to 50kHz, true rms

DM-8055($649.95) 5½ dgt
- 0.006% basic accuracy
- 1μV,1mΩ,1nA resolution
- dBm,auto,REL, min/max

DM-8055G($889.95)GPIB
- Same funct. as DM-8055

Intelligent Counters

FC-8131 ($469.95)1.3GHz
FC-8270 ($629.95)2.7GHz
UC-2010G ($294.95)

ALFA ELECTRONICS
P.O. BOX 8089
PRINCETON, NJ 08543

TEL: (800)526-ALFA(2532) / (609)897-1135
FAX: 609-897-0206
E-mail: alfa0168@aol.com

Call/Write/Fax/Email for **FREE CATALOG**

Visa, MC, AMEX, COD, PO Accepted OEM Welcome

1 Year Warranty (2 Years for GW/Instek)

CIRCLE 213 ON FREE INFORMATION CARD

ONLY COOL-AMP SILVERPLATES ON THE JOB.

From a customer testimonial:

"Ok, your edge connectors don't connect. Or you want to plate your own PC creations, but you don't want to bother with electro-plate solutions. The plating on the socket…has worn off and no longer makes reliable contact…what are you going to do now?

"Give the people at Cool-Amp a call. They have a silver plating compound I have used for the past couple of years that solves all of the above problems and more. This white powder has an infinite shelf life…and is easy to use.

"It will actually put a permanent silver plate on copper, brass or bronze…There are no messy or dangerous chemicals. Application could not be easier. Use a clean rag and a little bit of water and just rub it on a clean surface. In minutes you can permanently silver plate a circuit board or replate a power amp tube or socket.

"It has saved me time, money and my sanity."

Cool amp has even outperformed electroplating in recent tests. It is time-proven since 1944.

COOL-AMP

AND CONDUCTO-LUBE. *THE* SILVER-BASED CONDUCTIVE LUBRICANT.

The upstart, since 1952. Developed for switches, uses continue to expand to all applications needing a conductive lubricant.

Conducto-Lube

ORDER FACTORY DIRECT:
503-624-6426 or FAX 503-624-6436

http://www.thomasregister.com/cool-amp

CIRCLE 228 ON FREE INFORMATION CARD

WORLD'S SMALLEST
UHF X-tal Locked Video Transmitters $99.00

So small the transmitter, camera and battery will fit into a cigarette pack!!!

Used by hundreds in covert CCTV, R/C models, movie Special Effects, and Law Enforcement. "I've utilized your transmitters in covert video installations for about one year... previously, I used costly wireless units from Pelco, MVP, and Supercircuits. Nothing approaches the VidLinks in terms of power, picture quality, size, and value. Thank you." *R. Leslie, CCTV Installer, NY.*
"Incredible color, resolution... easy to use, convenient. Very cool." *P. Davis, Props, CA.*
"... like having a TV station in your pocket." *J. Ramsay, Electronic Hobbyist, FL.*

LIVE REMOTE VIDEO FROM: **$99.00** | ACTUAL SIZE !!!

VidLink 100: 100mW Power- upto 1/4 Mile
***$199.00* New! High-Power!**
VidLink 15: 15mW Power- upto 150 Feet
***$99.00* New! Low Price- Same Size!**
Covert Camera: 1 1/4" sq. Pinhole Lens
***$169.00* Pro Grade Japanese Quality!**
***** Audio Module Now Available. *Call.* *****
Check/MO, COD +$5.00, S&H $5.50

AEGIS RESEARCH
#671-1225 E. Sunset Dr.
Bellingham, WA
98226-3529 USA

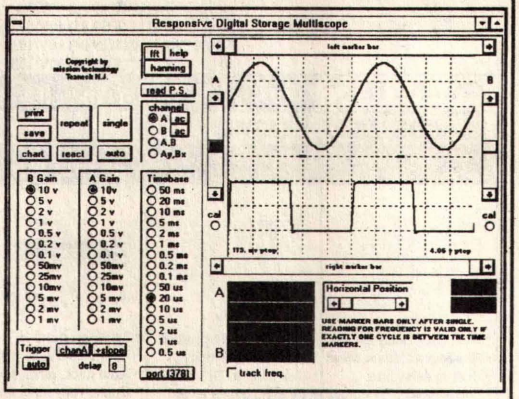
1-604-224-0416
Visit our virtual catalog on the INTERNET at:
http://www.lynx.bc.ca/virtualspy

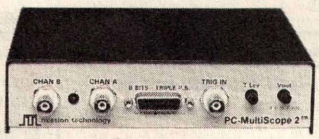
TURN YOUR PC INTO A DIGITAL STORAGE OSCILLOSCOPE!

The all new **PC-MultiScope 2**

10Mhz analog bandwidth!

At right: Actual scope screen as seen on your PC monitor.





For industrial, educational, hobbyist, auto, and audio test & measurement

$399 + S/H. Visa/MC/Check OK
Add $99 for source code option

FEATURES:
1. Dual channel; external triggered
2. Digital storage; Windows based
3. Connects to PC parallel port
4. 20Megasamples/sec sampling; 10Mhz max. analog bandwidth
5. 8 bit resolution/ 8K RAM buffer
6. Prog. gain: 10v/div to 1mv/div
7. Spectrum analyzer (fft) function
8. Strip chart recorder function
9. TTL output for control app's
10. Visual Basic source code avail.

The top choice of corporations, universities and scientists worldwide!

AMAZE ELECTRONICS CORPORATION
amaze@hooked.net www.hooked.net/users/amaze
Phone: 800-996-2008 Fax: 408-374-1737

MCM Electronics®

The Source For All Of Your Electronics Needs

To take advantage of special pricing on the items listed, please provide this code:

SOURCE CODE: ENS46

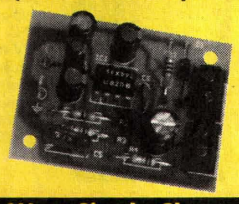
For over 20 years, MCM has been the leading supplier to the electronics service industry. Huge inventory, rapid delivery and competitive prices have made MCM the choice for:

- Hobbyists
- Service Technicians
- Educators
- Installers

Discover the MCM difference, call today for your free catalog.

These pre-assembled circuit modules are ideal for repairing or refurbishing old equipment, prototype work or hobby applications. MCM stocks many modules not listed here. For complete information, contact your MCM Sales Representative.

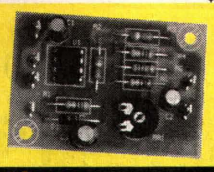
Prices Effective April 2 through May 29, 1998



One Watt Single Channel Audio Amplifier

Accepts line level input, 50mV, 100Kohm. Output impedance 4~8ohm. Operates with supply voltage from 4~14VDC, 200mA. Optimum 12VDC. Board dimensions 50mm x 35mm x 20mm. Many larger amplifier modules are available.

Order #	(ea.)
28-4795	$7.49

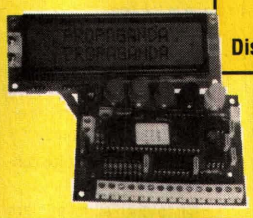


Microphone Preamp Module

May be used any amplifier with line level input. Gain is adjustable via board mounted potentiometer. Input level 560ohm, 5mV. Output level 1Kohm, 300mV. Operates with supply voltage from 6~18VDC, 5mA. Board dimensions 50mm x 35mm x 20mm.

Order #	(ea.)
28-4805	$8.95

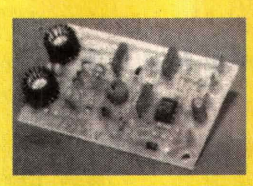
FREE Catalog!



Programmable LCD Display

One or two line x 16 character display is fully programmable and stores up to 14 alpha numeric messages. Backlit display allows viewing in any light. Messages can be individually displayed by closing specific contacts on terminal strip mounted to the board. Programming is easily done via a menu programming, similar to that of VCR or camcorder text. Data can be sent between multiple units to allow fast programming of a many units. Requires 12VDC, 300mA.

Order #	Description	(ea.)
28-4765	Single line	$115.00
28-4766	Two line	140.00

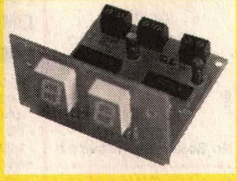


FM Transmitter

Accepts line level input (300mV), and transmits audio to any standard FM radio. Output frequency can be adjusted anywhere in the 88~108MHz FM band. Requires 9~15VDC supply, 150mA. Board dimensions 50mm x 65mm x 20mm.

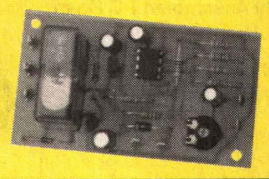
Order #	(ea.)
28-4851	$24.95

Two Digit LED Counter



Provides digital count from 0 to 99. Contact closure input provides one count up and reset-to-zero function. Each digit is 0.5" high. Requires 12VDC, 100mA. Dimensions 70mm x 52mm x 46mm.

Order #	(ea.)
28-4785	$14.95



Voice Activation (VOX) Relay

5A output relay is energized when audio signal level is detected. Input level 50mV, 10Kohm. Sensitivity is adjusted via a board mounted potentiometer. Requires 12VDC, 50mA. Board dimensions 75mm x 40mm x 30mm.

Order #	(ea.)
28-4825	$17.95

On Delay Timer Module

Provides precision time delay for a variety of uses. Upon contact closure, the output relay remains open, until a predetermined amount of time passes, then closes. The relay remains closed for a predetermined amount of time, then opens again. Both predetermined times are independently adjustable by two board mounted potentiometers. Relay contacts 5A. Requires 12VDC, 500mA. Board dimensions 43mm x 75mm x 30mm.

Order #	Delay Time	(ea.)
28-4750	1~180 second	$19.95
28-4751	2~45 minute	19.95

Need a convenient power supply?

This 13.5VDC, 1 amp AC adaptor is perfect for many hobby applications.

Order #	(ea.)
58-3330	$3.99

1-800-543-4330

www.mcmelectronics.com

Hours: M~F 7 a.m.~9 p.m., Sat. 9 a.m.~6 p.m., EST.

Same Day Shipping!

In stock orders received by 5:00 p.m. (YOUR TIME), are shipped the same day.

MCM ELECTRONICS®
650 CONGRESS PARK DR.
CENTERVILLE, OH 45459
A PREMIER FARNELL Company

SOURCE CODE: ENS46

CIRCLE 327 ON FREE INFORMATION CARD

CALL TOLL FREE
(800) 292-7711 orders only
Se Habla Español

C&S SALES
EXCELLENCE IN SERVICE

LOOK FOR OTHER MONTHLY SPECIALS ON OUR WEBSITE

XK-700 Digital / Analog Trainer

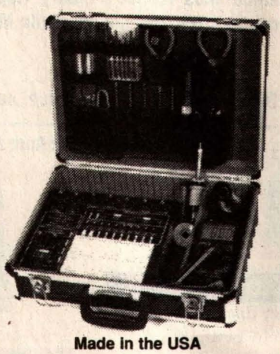
NEW

Elenco's newest advanced designed Digital / Analog Trainer is specially designed for school projects. It is built on a single PC board for maximum reliability. It includes 5 built-in power supplies, a function generator with continuously sine, triangular and square waveforms and a 1560 tie point bredboard area. Tools and meter shown optional. (Mounted in a professional tool case made of reinforced metal).

XK-700
Assembled and Tested
$189.95

XK-700 - SEMI KIT
w/ Fully Assembled PC Board
$174.95

XK-700K - Kit
$159.95



Made in the USA

Volt Alert™ By FLUKE

Volt Alert™ is the new pocket-sized AC line voltage detector from Fluke. Easy to use - just touch the tip to an outlet or cord. When it glows red, you know there's voltage in the line.
Electrician's, maintenance, service, and safety personel can quickly test for energized circuits and defective grounds on the factory floor, in the shop, or at home.

- Fits in shirt pocket for convenience.
- All outer surfaces are unconductive for safety.

Detects voltage metallic contact.

#1AC $19.50

DIGITAL LCR METER
Model LCR-1810

NEW

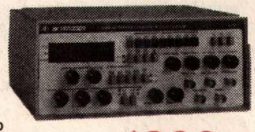
$99.95

- Capacitance .1pF to 20µF
- Inductance 1µH to 20H
- Resistance .01Ω to 2000MΩ
- Temperature -20°C to 750°C
- DC Volts 0 - 20V
- Frequency up to 15MHz
- Diode/Audible Continuity Test
- Signal Output Function
- 3 1/2 Digit Display

20MHz Sweep / Function Generator with Freq Counter

B&K 4040

- 0.2Hz to 20MHz
- AM & FM modulation
- Burst Operation
- External Frequency counter to 30MHz
- Linear and Log sweep



10MHz B&K 4017 $309
5MHz B&K 4011 $239

$399

Model M-6100

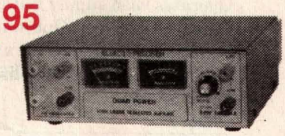
The M-6100 is Elenco's most sophisticated meter with almost every possible feature available. The M-6100 even has a computer interface for viewing and storing data on a personal computer. It comes complete with software, RS-232 cable, test leads and manual.

$125

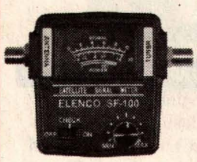
Model XP-581

4 Fully Regulated DC Power Supplies in One Unit
4 DC voltages: 3 fixed - +5V @ 3A, +12V @ 1A, -12V @ 1A
1 Variable - 2.5 - 20V @ 2A

$89.95



SATELLITE FINDER
Model SF-100A



- Aligns Satelite Dishes
- Range 950-2050MHz
- Audio Tone
- Compact Size
- Self Power Check

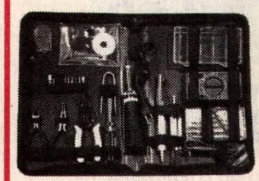
$39.95

Digital Multimeter
Model M-1700

$39.95

11 functions including freq to 20MHz, cap to 20µF. Meets UL-1244 safety specs.

Technician Tool Kit
TK-1500



28 tools plus a DMM contained in a large flexible tool case with handles ideal for everyone on the go.

$49.95

Kit Corner
over 100 kits available

AK-700
$14.95

Phone kit with training course.

RADIO CONTROL CAR KIT
MODEL AK-870

- 7 functions
- Remote control included

$24.95

No Soldering Required

Model AM/FM-108K Transistor Radio Kit
with training course

$29.95

35mm Camera Kit
Learn all about photography
AK-540

$14.95

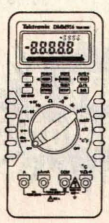
No Soldering Required

The New DMM900 Series Handheld Digital Multimeters

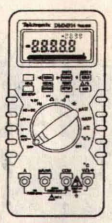
For high-performance digital multimeters that are accurate, reliable, and rugged, the DMM900 Series extends the Tektronix line of already affordable DMMs. Twice the accuracy. Up to 10 times the resolution. And a full range of capability that spans voltage, current, digital multimeters features a dual numeric display, 3-year warranty, and autoranging capability. All backed by the reliability of the Tektronix brand.

Features
DMM912, DMM914, DMM916

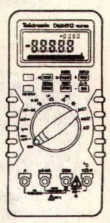
- 40,000 Count Display
- 0.06% Basic DC Volts Accuracy (DMM916)
- DC Voltage Ranges from 400mV to 1,0000 V
- AC Voltage Ranges from 4V to 750V (True RMS)
- AC and DC Current Ranges from 10,000µA to 10A
- Resistance Ranges from 400Ω to 40MΩ
- Capacitance Ranges from 4nF to 40µF
- Frequency Ranges from 400Hz to 2MHz
- Temperature Measurements from -50°C to +980°C (DMM916, DMM914)
- 3 Year Warranty
- CE Marking



DMM 912 $189



DMM 914 $235



DMM 916 $275

GUARANTEED LOWEST PRICES ON TEK DMMs

WE WILL NOT BE UNDERSOLD

C&S SALES, INC.
150 W. CARPENTER AVENUE
WHEELING, IL 60090
FAX: (847) 541-9904 (847) 541-0710
http://www.elenco.com/cs_sales/

UPS SHIPPING: 48 STATES 5%
OTHERS CALL FOR DETAILS
IL Residents add 8.25% Sales Tax

VISA MasterCard

15 DAY MONEY BACK GUARANTEE
FULL FACTORY WARRANTY
PRICES SUBJECT TO CHANGE WITHOUT NOTICE

CIRCLE 322 ON FREE INFORMATION CARD

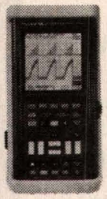
Same Day Shipping

C & S SALES

Your one stop source for all your electronic needs!

CALL OR WRITE FOR OUR NEW FREE 64 PAGE CATALOG!
(800) 445-3201

Fluke Scopemeters



123....NEW.....$950
92B.....$1445
96B.....$1695
99B...NEW....$2095
105B.....$2495

ALL FLUKE PRODUCTS ON SALE

B & K PRECISION SCOPES

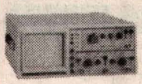
100MHz THREE-TRACE
Model 2190A
- 1mV/division sensitivity
- Sweeps to 5ns/division
- Dual time base
- Signal delay line
- 15KV accelerating voltage

$1295.00

60MHz DUAL-TRACE
Model 2160
- 1mV/division sensitivity
- Sweeps to 5ns/division
- Dual time base
- Signal delay line
- V mode-displays two signals unrelated in frequency.
- Component tester

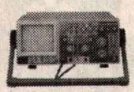
$895.00

40MHz DUAL-TRACE
Model 1541C
- 1mV/division sensitivity
- Video sync separators
- Z-axis input
- Single Sweep
- V mode displays two signals unrelated in frequency
- Component tester



$695

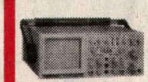
60MHz, CURSORS & READOUTS, DUAL TIME BASE
Model 2260
- Cursors and readouts
- 1mV/div sensitivity
- 23 calibrated ranges - main time base
- 19 calibrated ranges - delayed time base
- Signal delay time
- V-mode - displays 2 signals unrelated in frequency.
- Component tester
- Z-axis input
- Single sweep



$1225

20MHz DUAL-TRACE
Model 2120B - 2 Year Warranty
Special $375

Model 2125A with delayed sweep
$539.95



- 1mV/division sensitivity
- AUTO/NORM triggered sweep operation
- AC, TVH, TVV and line coupling
- Calibrated 19 step time-base with x10 magnifier
- Compact low-profile design

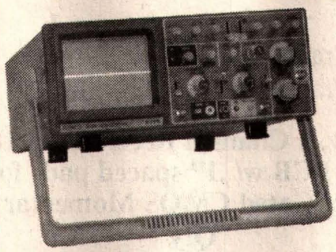
Affordable Spectrum Analyzers by B&K

500MHz Series
Model 2615 - $1595
Model 2620 w/ tracking generator - $1895

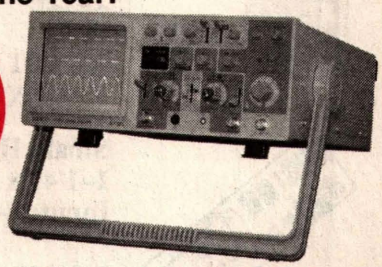
1.05GHz Series
Model 2625 - $2395
Model 2630 w/ tracking generator - $2995

Quality Scopes by Elenco

Lowest Prices of the Year!



Includes Free Dust Cover and Probes



60MHz

DS-603 $1350
- Analog / Digital Storage
- 20MS/s Sampling Rate

S-1360 $749
- Analog with Delayed Sweep

100MHz

S-1390 $995
- Analog

40MHz

S-1345 $569
- Analog with Delayed Sweep

S-1340 $475
- Analog

2 Year Warranty

25/30MHz

DS-303 30MHz $1095

DS-203 20MHz $725
- Analog / Digital Storage

S-1330 $439
- 25MHz Analog
- Delayed Sweep

S-1325 $325
- 25MHz Analog

SIMM MODULE TESTER

B & K 898 $625
- Tests 72 and 30-pin SIMMs to 36 bits.
- Stand alone and portable. No other equipment required.
- Automatically identifies width, depth and speed of SIMMS.
- 10 built-in tests identify most memory defects. Preheat cycle prior to test.

PORTABLE SEMICONDUCTOR TESTER

B&K 510
- In or out-of-order circuit tests for transistor, FETs, SCRs and darlingtons.

$199.00

Fluke Multimeters

Model 70III	$85	Model 83	$235
Model 73III	$115	Model 85	$269
Model 75III	$139	Model 87	$289
Model 77III	$154	Model 863E	$475
Model 79III	$175	Model 867BE	$650

B&K Precision Multimeters

Model 391	$143	Model 388A	$99
Model 390	$127	Model 2707	$75
Model 389	$109	Model 2860A	$79
Model 5390	$295	Model 5370	$219
Model 5380	$265	Model 5360	$195

MX-9300

Four Functions in One Instrument

Features:
- One instrument with four test and measuring systems:
  - 1.3GHz Frequency Counter
  - 2MHz Sweep Function Generator
  - Digital Multimeter
  - Digital Triple Power Supply
- 0-30V @ 3A, 15V @ 1A, 5V @2A

$459.95

GUARANTEED LOWEST PRICES

UPS SHIPPING: 48 STATES 5%
OTHERS CALL FOR DETAILS
IL Residents add 8.25% Sales Tax

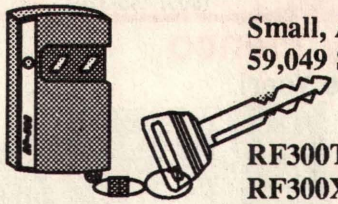
C&S SALES, INC.
150 W. CARPENTER AVENUE
WHEELING, IL 60090
FAX: (847) 541-9904 (847) 541-0710
http://www.elenco.com/cs_sales/

VISA MasterCard

15 DAY MONEY BACK GUARANTEE
FULL FACTORY WARRANTY
PRICES SUBJECT TO CHANGE WITHOUT NOTICE

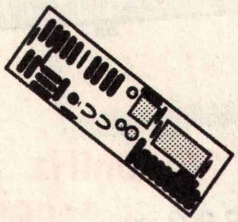
CIRCLE 322 ON FREE INFORMATION CARD

Miniature Transmitters and Receivers



Small, Attractive, High End Quality, 2 Channel 318 MHz Transmitter
59,049 Settable Codes, 120'–300' Range, 1–1/4" x 2" x 9/16", Assembled

	Qty	1	5	10
RF300T	150' Range Transmitter	24.95	19.95	15.95
RF300XT	300' Range Transmitter	29.95	24.95	19.95



Small, High End Quality, 2 Channel Receiver for the RF300 Transmitters
1–1/4" x 3–3/4" x 9/16" PCB w/ .1" spaced pads for standard connectors
Input: 8–24 vdc Output: Gated CMOS Momentary and Latching Lines

	Qty	1	5	10
RF300R	Receiver, Fully Assembled	24.95	20.95	16.95
RF300RK	Receiver, Complete Parts Kit	19.95	15.95	12.95
RF300PA	Pre–Amplifier. Doubles Range	14.95	11.95	9.95

Small, Economical, Single Channel Transmitter and Receiver Set
Set Code, 60' Range, 1–7/8"x2–3/8"x7/16" (T), 2"x2–3/4"x9/16" (R)
Receiver Input: 5 vdc Output: Gated TTL Momentary Line

	Qty	1	5	10
RF60	Transmitter and Receiver Set	24.95	19.95	14.95

Add $ 4 shipping for first item + $ 1 for each additional item. Ca. residents add 8.25% tax
Visa, Mastercard, Money Orders Personal Checks and Cash C.O.D.s

Visitect Inc.

P.O. Box 14156 Fremont, CA. 94539 (510) 651–1425 Fax (510) 651–8454

CIRCLE 317 ON FREE INFORMATION CARD

❖ ATTENTION CABLE VIEWERS ❖

CABLE VIEWERS. . .get back to your BASIC Cable Needs

Call 800-577-8775
For information regarding all of your BASIC cable needs.

5 GOOD REASONS TO BUY OUR FAR SUPERIOR PRODUCT

- ❖ PRICE
- ❖ EFFICIENT SALES AND SERVICE
- ❖ WE SPECIALIZE IN 5, 10 LOT PRICING
- ❖ ALL FUNCTIONS (COMPATIBLE WITH ALL MAJOR BRANDS)
- ❖ ANY SIZE ORDER FILLED WITH SAME DAY SHIPPING

We handle NEW equipment ONLY - Don't trust last year's OBSOLETE and UNSOLD stock!
COMPETITIVE PRICING—DEALERS WELCOME

HOURS: Monday-Saturday 9-5 C.S.T.

It is not the intent of B.E.S.W. to defraud any pay television operator an we will not assist any company or individual in doing the same.
*Refer to sales personnel for specifications.

BASIC ELECTRICAL SUPPLY & WAREHOUSING CORPORATION

P.O. Box 8180 ■ Bartlett, IL 60103 ■ 800-577-8775

CIRCLE 313 ON FREE INFORMATION CARD

OVER 30,000 ITEMS IN STOCK

Dalbani®

The Ultimate Saving Source

LARGE VARIETY
SAME DAY SHIPPING

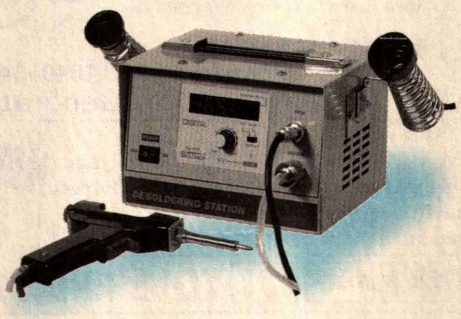
Over 6,000 new items

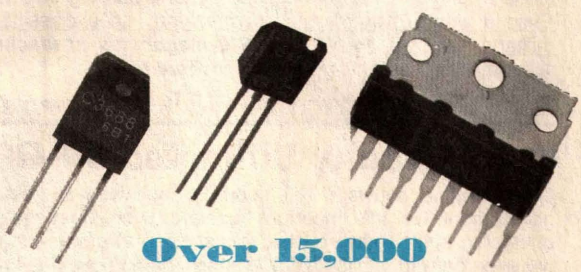
SHIP UP TO **5lbs** FOR ONLY **$3.95**

UPS 2nd Day Air

Plus handling & C.O.D. charge if it applies

- Audio/Video Service Parts
- Audio/Video Accessories
- Professional Audio
- Security Products
- Connectors
- Technician Aids
- Chemicals
- Test Equipments
- Soldering Equipment
- Automotive Products
- Automotive Installation Kits





Over 15,000
Original SEMI in stock.

Dalbani®
4225 NW 72ND AVE. MIAMI, FLORIDA 33166
TEL : (305) 716-1016 ----- FAX : (305) 594-6588

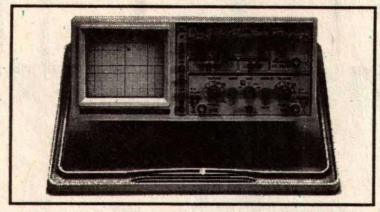
TO ORDER A CATALOG CALL "258"

1-800-325-2264

CIRCLE 315 ON FREE INFORMATION CARD

New and Pre-Owned Test Equipment

Goldstar



Model OS-9100P ⟶ $899.00

Full 100 MHz Bandwidth!

- Dual-Channel, High Sensitivity
- TV Synchronization Trigger
- Calibrated Delayed Sweep
- Includes Two Probes, 2 Year Warranty

FREE SHIPPING! ON GOLDSTAR EQUIPMENT ANYWHERE IN THE U.S. Excluding AK & HI

BK PRECISION MAXTEC INTERNATIONAL CORP. **Model 4040 $499.00**

20 MHz Sweep/Function Generator

- 0.2 Hz to 20 MHz, 5 digit LED Display
- AM & FM Internal or External Modulation
- Sine, Square, Triangle, TTL, CMOS Outputs
- Burst Operation
- External 30 MHz Frequency Counter

NEW!

Pre-Owned Oscilloscope Specials

B+K Precision 1476 10 MHz $229.00
Great Starter Scope!

Tektronix 465	100 MHz	$599.00
Tektronix 465B	100 MHz	$699.00
Tektronix 475	200 MHz	$799.00
Tektronix 475A	250 MHz	$899.00

- The Industry Standard of Oscilloscopes
- Dual Channel, Calibrated Delayed Sweep
- Professionally Refurbished
- Aligned & Calibrated to Original Specifications
- 6 Month Warranty - The Longest Available!

LOWEST PRICES EVER!

NEW FLUKE MULTIMETERS & TEKTRONIX OSCILLOSCOPES

The Industry Standard in Multimeters
Fluke Model 87 ..$285.00

TEKTRONIX TDS SERIES ON SALE!

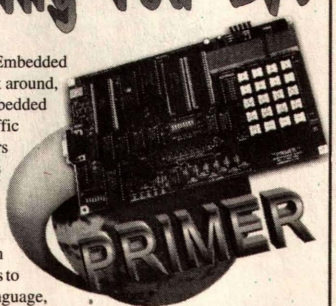
See us on the Web!
www.fotronic.com

Test Equipment Depot
A FOTRONIC CORPORATION COMPANY
P.O. BOX 708 Medford, MA 02155
(617) 665-1400 • FAX (617) 665-0780
email: afoti@fotronic.com

VISA MasterCard AMEX C.O.D. **TOLL FREE 1-800-99-METER**
1-800-996-3837

CIRCLE 328 ON FREE INFORMATION CARD

World Passing You By?



Are you interested in Microprocessors & Embedded Control Systems? If not you should be! Look around, just about everything these days has an embedded microprocessor in it. TVs, cars, radios, traffic lights & even toys have embedded computers controlling their actions. The Primer Trainer is the tool that can not only teach you how these devices operate but give you the opportunity to program these types of systems yourself. Examples & exercises in the Self Instruction manual take you from writing simple programs to controlling motors. Start out in Machine language, then move on to Assembler, & then continue on with optional C, Basic, or Forth Compilers. So don't be left behind; this is information you need to know!

Examples Include:

- Measuring Temperature
- Using a Photocell to Detect Light Levels
- Making a Waveform Generator
- Constructing a Capacitance Meter
- Motor Speed Control Using Back EMF
- Interfacing and Controlling Stepper Motors
- Scanning Keypads and Writing to LCD/LED Displays
- Bus Interfacing an 8255 PPI
- Using the Primer as an EPROM Programmer
- DTMF Autodialer & Remote Controller (New!)

The PRIMER is only $119.95 in kit form. The PRIMER Assembled & Tested is $169.95. This trainer can be used stand alone via the keypad and display or connected to a PC with the optional upgrade ($49.95). The Upgrade includes: an RS232 serial port & cable, 32K of battery backed RAM, & Assembler/Terminal software. Please add $5.00 for shipping within the U.S. Picture shown with upgrade option and optional heavy-duty keypad ($29.95) installed. Satisfaction guaranteed.

EMAC, inc.
11 EMAC WAY, CARBONDALE, IL 62901
618-529-4525 Fax 457-0110 BBS 529-5708
World Wide Web: http://www.emacinc.com

1985 - 1998 OVER 12 YEARS OF SERVICE

THE HACKER'S COMPANION CD-ROM

Are you interested in using the internet in ways you never dreamed possible? Want a war-dialer program or something to crack a password? Do you want to learn how the phone company gets ripped off, or learn how to build a red box, or modify a cellular phone? Want to see what the security holes in Windows NT are? Or how to compromise a Unix machine or a BBS? Want to learn how to use the system in ways you never imagined possible? This CD is the place to look! It contains all kinds of computer telephone and general hacking information. Even a video of dutch hackers breaking into a classified US military computer! ***In all, over 600 megabytes of fascinating information that's hard to get anywhere else!***

PC-COMPATIBLE CD $29.95 SHIPPING $3

Cryptography Unlimited CD-ROM

Cryptographic software will soon be outlawed by the US government. Get this important bundle of over 200 megabytes of cryptographic software while you still can! Nobody in the US will even dare to publish a CD like this anymore and we had to import it from Africa! Includes file encryptors, disk encryptors, PGP, steganography, code cracking, PGP phone and lots more! **PC CD-ROM, $39.95 SHIPPING $3**

Call (800)719-4957 now!
to order (Visa/MC/COD) or call or write for **FREE CATALOG** of hard-to-get information about *computer viruses, computer hacking, security and cryptography!!*

American Eagle Publications, Inc.
P. O Box 1507, Dept E.
Show Low, AZ 85901

CIRCLE 282 ON FREE INFORMATION CARD

Our Complete Catalog is now online

www.cir.com

Circuit Specialists Inc.

SINCE 1971

Check Out What We Have To Offer:

Fantastic DMM Offer!!!

Don't let the price fool you. This meter is a digital multimeter designed for engineers and hobbyists. Equipped with 5 functions and 19 ranges. Each test position is quickly and easily selected with a simple turn of the FUNCTION/RANGE selector rotary switch.

Our Best Offer Ever on a High Quality Full Sized DMM

Rubber Boot Included

General

Display: 3-1/2 Digit LCD, 21mm Figure Height with Automatic Polarity
Overrange Indication: 3 Least Significant Digits Blank
Temperature for Guaranteed Accuracy: 23 C 5 C RH<75%
Temperature Ranges: Operating: 0 C to 40 C (32 F to 104 F) Storage: -10 C to 50 C (14 F to 122 F)
Power: 9V Alkaline or Carbon-Zinc Battery(NEDA1604)
Low Battery Indication: BAT on Left of LCD Display
Dimensions: 188mm long x 87mm wide x 33mm thick
Net Weight: 400g

DC Voltage (DCV)

Range:	Resolution:	Accuracy:
200mV	100 V	
2000mV	1mV	(1%rdg+2dgts)
20V	10mV	
200V	100mV	
1000V	1V	

Maximum Allowable Input: 1000V DC or Peak AC.

DC Current (DCA)

Range:	Resolution:	Accuracy:
200 A	100nA	
2000 A	1 A	(1.2%rdg+2dgts)
20mA	10 A	
200mA	100 A	(1.2%rdg+2dgts)
10A	10mA	

Overload Protection: mA Input. 2A/250V fuse.

Resistance (Ω)

Range:	Resolution:	Accuracy:
200Ω	100mΩ	
2000Ω	1Ω	
20KΩ	10Ω	(1.2%rdg+2dgts)
200KΩ	100Ω	
2000KΩ	1KΩ	
20MΩ	10KΩ	(2%rdg+10dgts)

Maximum Open Circuit Voltage: 2.8V

Diode Test

Measures forward voltage drop of a semiconductor junction in mV test current of 1.5mA Max.

ohFE Test

Measures transistor hFE.
Frequency Range: 45Hz-450Hz
Maximum Allowable Input: 750V rms
Response: Average Responding. Calibrated in rms of a Sine Wave.

AC Voltage (ACV)

Range:	Resolution:	Accuracy:
200V	100mV	(1.2%rdg+10dgts)
750V	1V	

$19.00 any qty

CAT NO	DESCRIPTION	PRICE
9300G	Rugged High Quality DMM with Rubber Boot	$19.00

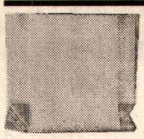
20 AMP Switching Power Supply

$99.00 any qty

A very special Circuit Specialists offer. This 20 amp continuous switching power supply is available at this fantastic low price!

Specifications
Input Voltage: AC 110V +/- 15%, 50Hz/60Hz
Output Voltage: DC9V 15V variable
Polarity: Negative ground
Current (13.8v): 25A peak, 20A continuous
Overvoltage Protection
Cooling fan inside chassis

CAT NO	DESCRIPTION	PRICE
SPS-1020G	20 Amp Switching Power Supply	$99.00



Developer This product is used as the developer on our positive photo-resist printed circuit boards. Includes instructions. 50 gram package, mixes with water, makes 1 quart.

CAT NO	DESCRIPTION	PRICE EACH 1	10	25
POSDEV	Positive Developer	$ .95	$ .80	$ .50

Etching Chemicals/Ferric Chloride

A dry concentrate that mixes with water to make 1 pint of etchant, enough to etch 400 sq. inches of 1oz board.

CAT NO	DESCRIPTION	PRICE EACH 1	5
ER-3	Makes 1 pint	$3.50	$2.75

Positive Photo Resist Pre-Sensitized Printed Circuit Boards

These pre-sensitized printed circuit boards are ideal for small production runs. They provide high resolution and excellent line width control. High sensitive positive resist coated on 1oz. copper foil allows you to go direct from your computer plot or art work layout. No need to reverse art.

Single-Sided, 1oz. Copper Foil on Paper Phenolic Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
PP101	100mm x 150mm/3.91" x 5.91"	$2.55	$1.90	$1.70
PP114	114mm x 165mm/4.6" x 6.6"	2.98	2.45	1.98
PP152	150mm x 250mm/5.91" x 9.84"	5.40	3.98	3.60
PP153	150mm x 300mm/5.91" x 11.81"	6.15	4.48	4.10
PP1212	305mm x 305mm/12" x 12"	12.78	10.65	8.52

Single-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GS101	100mm x 150mm/3.91" x 5.91"	$ 3.90	$2.98	$2.60
GS114	114mm x 165mm/4.6" x 6.6"	4.80	3.49	3.20
GS152	150mm x 250mm/5.91" x 9.84"	8.69	5.98	5.78
GS153	150mm x 300mm/5.91" x 11.81"	10.20	7.20	6.80
GS1212	305mm x 305mm/12" x 12"	18.88	15.73	12.59

Double-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GD101	100mm x 150mm/3.91" x 5.91"	$ 5.07	$3.68	$3.38
GD114	114mm x 165mm/4.6" x 6.6"	5.95	4.29	3.99
GD152	150mm x 250mm/5.91" x 9.84"	10.47	7.39	6.98
GD153	150mm x 300mm/5.91" x 11.81"	11.95	8.69	8.30
GD1212	305mm x 305mm/12" x 12"	22.09	18.35	14.68

Etching Tank This handy etching system will handle PC boards up to 8" x 9", two at a time. Ideal for etching your PCB's! System includes an air pump for etchant agitation, a thermostatically controlled heater for keeping etchant at optimum temperature and a tank that holds 1.35 gallons of etchant. A tight fitting lid is also supplied to prevent evaporation when system is not being used. Typical etching time is reduced to 4 minutes on 1oz. copper board!

REDUCES ETCHING TIME!

CAT NO	DESCRIPTION	PRICE
12-700	Etch Tank System	$37.95

1/3" CCD Board Cameras

Available with **PINHOLE LENS** with **AUDIO**; **STANDARD LENS** with **AUDIO**; and **STANDARD LENS** with **INFRA-RED**. These are the world's smallest commercially available CCD board cameras!

World's Smallest B&W Board Cameras

WDP-2000

WDS-2005

WDI-4000

Specifications

Image Pick-Up Device	1/3" CCD area Sensor
Picture Elements	EIA=512(H) x 492(V)
Pixel Pitch	EIA=9.6UM (H) x 7.5UM (V)
Scanning System	2 : 1 Interlace
Scanning Frequency	EIA=525 lines, 60 field/sec (II) 15.750 KHz x 60 HK
Resolution	430 Lines
Minimum Illumination	0.03 LUX
S/N Ratio	45DB
Lens Mounting	4.3mm standard, 5mm pinhole
Video Output	1.0 VP-P/750OHM composite signal
Power Requirement	8-12 VDC (9VDC standard)
Power Consumption	100mA
Operating Temperature	-20C -+ 70 C RH 95% Max
Storage Temperature	-40C -= 85 C RH 95% Max
Audio Pick-Up Sensitivity	-60 DB (0DB = 1B/UBAR. 1KNZ)
Audio Frequency Range	20 Hz to 20KHz
Audio S/N Ratio	More than 35DB
Audio Output Level	1VP-P/600 OHM

Dimensions

WDP-2000	30mm (H) x 30mm (W)
WDS-2005	30mm (H) x 30mm (W)
WDI-4000	44mm (H) x 30mm (W)

CAT NO	DESCRIPTION	PRICE EACH 1	5
WDP-2000	1/3" B&W Pinhole Lens with Audio	$89.00	$77.00
WDS-2005	1/3" B&W Standard Lens with Audio	89.00	77.00
WDI-4000	1/3" B&W Infra-RED (no audio)	89.00	77.00
WDPH-55BW	Plastic Housing Option for B&W Board Cameras (WDP-2000 & WDS-2005 ONLY)	13.00	12.00

CIRCUIT SPECIALISTS, INC.

SINCE 1971

800-811-5203
602-464-2485
602-464-5824(FAX)

WE ACCEPT: VISA MasterCard NOVUS

RECEIVE OUR LATEST 132 PAGE CATALOG!

It's chock full of all types of electronic equipment and supplies. We've got I.C.'s, capacitors, resistors, pots, inductors, test equipment, breadboarding supplies, PC supplies, industrial computers, data acquisition products, personal computers and computer parts, plus much, much more. FAX us your name and address or call **800-811-5203, ext. 5,** to leave a message on our catalog request line.

CIRCLE 332 ON FREE INFORMATION CARD

Tel: (954) 974-6864
Fax: (954) 974-6818

GATEWAY PRODUCTS CORP.

Please mail orders to:
P. O. Box: 93-6397
Margate, FL 33093

Deal U3.....$5.00
LM324
LM339
LM358
NE555
LM556
LM741
Linear ICs
(12pcs total.....2 pcs ea)

Deal N1.....$3.00
PN2222A
2N3904
2N4401
NPN Transistors
(30pcs total....10pcs ea)

Deal P9.....$3.00
1N4148 .....switching
1N4001 .....1A/50V
1N4004 .....1A/400V
1N4007 .....1A/1kV
Diodes
(40pcs total....10pcs ea)

Deal A2.....$3.50
1uF 10uF
2.2uF 22uF
3.3uF 33uF
4.7uF 47uF
All caps: 50V
Radial Lytics
(40pcs total.....5 pcs ea)

Deal A7.....$4.00
10uF 100uF
22uF 220uF
33uF 330uF
47uF 470uF
All caps: 25V
Radial Lytics
(40pcs total.....5 pcs ea)

Deal R4.....$3.00
10pF 47pF
22pF 100pF
27pF 150pF
33pF 220pF
All caps: 50V
Ceramic Disc
(40pcs total.....5 pcs ea)

Deal T6.....$3.50
1uF/35V
2.2uF/35V
10uF/16V
Tantalum Caps
(15pcs total.....5 pcs ea)

Deal V8.....$5.00
CD4001B
CD4011B
CD4013B
CD4017B
CD4028B
CD4050B
CD4066B
CD4069B
CMOS ICs
(16pcs total.....2 pcs ea)

Deal N9.....$3.00
PN2907A
2N3906
2N4403
PNP Transistors
(30pcs total....10pcs ea)

Deal H8.....$4.00
1N5401 ..... 3A/100V
1N5404 ..... 3A/400V
1N5408 ..... 3A/1kV
6A10 ..... 6A/100V
6A100 ..... 6A/1kV
Power Diodes
(25pcs total.....5 pcs ea)

Deal G5.....$3.00
1N34A, 1N60, 1N270
Germanium Diodes
(18pcs total.....6 pcs ea)

Deal X8.....$3.00
1Amp
4Amp
1.5Amp
DF04M .....DIP
W04M.....Round
KBL04.....In-line
400V Bridges
(6 pcs total.....2 pcs ea)

Deal R7.....$3.00
270pF .01uF
330pF .022uF
470pF .047uF
.001uF .1uF
All caps: 50V
Ceramic Disc
(40pcs total.....5 pcs ea)

Super Specials
(10 pcs min. No mix)
2N2222A... 25¢
2N3055 ..... 50¢
74LS174 ... 20¢
74LS244 ... 20¢
74LS245 ... 20¢
74LS374 ... 20¢
LF353N ..... 25¢
LM386N .... 25¢
LM393N .... 25¢
MC1488 .... 25¢
MC1489 .... 25¢
Crystals..... 50¢
4.000MHz
11.000MHz
11.0592MHz
1/4" pushbutton
Normally Open
only ..... 20¢
LM317T..... 40¢
7818..... 20¢
79L05..... 20¢

Deal Q2.....$4.00
MPSA05
MPSA13
MPSA27
MPSA42
MPSA56
MPSA92
Transistors
(30pcs total.....5 pcs ea)

Deal Y6.....$2.00
1N5817 .....1A/20V
1N5818 .....1A/30V
1N5819 .....1A/40V
1Amp Schottky Diodes
(9 pcs total.....3 pcs ea)

Deal Z7.....$3.00
1N4728A 3.3V
1N4733A 5.1V
1N4739A 9.1V
1N4742A 12V
1N4744A 15V
1Watt Zener Diodes
(25pcs total.....5 pcs ea)

Deal C5.....$4.00
TIP 31C
TIP 32C
TIP 120
TIP 125
Transistors
(8 pcs total.....2 pcs ea)

Deal B5.....$3.50
.01uF .047uF
.022uF .1uF
50V Monolithic Caps
(40pcs total....10pcs ea)

Deal M4.....$5.00
7805 7812
7808 7815
12 pcs total
(3pcs of each)

Deal M5.....$5.00
7905 7912
7908 7915
12 pcs total
(3pcs of each)

Deal J1.....$3.50
78L05
78L12
10 pcs total
(5pcs of each)

Deal Y9.....$3.00
1N5820 .....3A/20V
1N5821 .....3A/30V
1N5822 .....3A/40V
3Amp Schottky Diodes
(9 pcs total.....3 pcs ea)

Deal W2.....$3.00
120pcs total....20 pcs of each: 10, 47, 100, 470, 1k, 4.7K. All 1/4W 5%.

Deal W5.....$3.00
100pcs total....20 pcs of each: 10K, 47K, 100K, 470K, 1M. All 1/4W 5%.

Deal S3.....$5.00
Miniature size
1/4" Panel hole
spdt..... on-on
spdt.... on-off-on
dpdt..... on-on
dpdt.... on-off-on
(8 pcs total.....2 pcs ea)

Deal L3.....$3.00
5mm (T1 3/4)
Diff'd LEDs
Red, Green and Yellow
30 pcs total
(5pcs of each)

Deal L6.....$3.00
3mm (T1)
Diff'd LEDs
Red, Green and Yellow
30 pcs total
(5pcs of each)

6ft Printer cable... $1.00
6ft VGA Cable $1.00
IDE Cable $1.00
Floppy Cable $1.00
Mouse Pad $1.00
Serial Mouse $7.00

VISA MasterCard
$20.00 minimum order. We accept VISA, MC, Check, No-CODs. Please add $5.00 for shipping & handling (foreign addresses: $9.00). Florida addresses add your applicable county sales tax. Hours: Mon-Fri: 9AM to 5PM (EST). All new premium parts. Send for free Catalog.

CIRCLE 334 ON FREE INFORMATION CARD

CAPITAL ELECTRONICS INC.

"QUALITY IS OUR CAPITAL CONCERN."

Complete On Site Electrical Engineering Lab

- PRODUCT ENGINEERING
- FIRMWARE DEVELOPMENT
- REVERSE ENGINEERING
- RF CIRCUIT DESIGN & MANUFACTURING
- MICRO CONTROLLER & EPROM HARDWARE & SOFTWARE DEVELOPMENT

From Auto-Routing to CNC Routing to Electronic Assemblies. . .
Capital Electronics is Your Best Route For Printed Circuit Boards.

DESIGN/LAYOUT
- CAD LAYOUT SERVICES
- COMPATIBLE WITH ALMOST ALL CAD SYSTEMS
- FROM SCHEMATICS OR SAMPLE PCB'S
- PHOTOPLOTTING SERVICES
- 28,800 BAUDE MODEM

PRINTED CIRCUIT BOARDS
- SINGLE & DOUBLE SIDED
- MULTI-LAYER & FLEXIBLE PCB'S
- FROM QUICK TURN PROTOYPES TO SCHEDULED PRODUCTION RUNS
- FINE LINES, SMT
- ELECTRICAL TESTING
- PRECIOUS METAL PLATING

ASSEMBLY SERVICES
- FAST TURN BOARD STUFFING
- WIRE HARNESSES
- WAVE SOLDERING
- ACQUISITION OF PARTS
- FINAL TESTING
- TURNKEY SERVICES
- CUSTOM ENCLOSURES

For Quick & Competitive Pricing or More Information, Please Call Us Today!

303 Sherman Street • Ackley, Iowa 50601
(515) 847-3888
Fax (515) 847-3889 • Modem (515) 847-3890

VISA MasterCard AMERICAN EXPRESS

Internet Access:
For Automated Info Response: INFO@capital-elec.com
E-Mail: Quote@capital-elec.com
Web Access: http://www.capital-elec.com

CIRCLE 320 ON FREE INFORMATION CARD

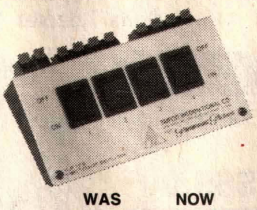
PARTS EXPRESS
ELECTRONICS & MORE

FREE 244 PAGE CATALOG

UNBELIEVABLE VALUE!

4 Way Speaker Switch

Control up to 4 pairs of speakers with this compact speaker selector switch. Features circuit protector, heavy duty rocker switches, spring loaded terminals, and silver plated switch connectors. Includes one pair of amplifier inputs. Load to amplifier is minimum 4 ohms (with 8 ohm speakers) or 220 ohms with all speakers switched off. Net weight: 1 lb.



	WAS	NOW
#EN-309-030	$22.50 EACH	$15.00 EACH

"The Sound Bridge" FM Stereo Wireless Transmitter

HOT NEW ITEM!

The Sound Bridge is a mini FM wireless transmitter that can be used to broadcast stereo sound from any audio source like portable CD players, TVs, electronic games, CD-ROM, even computer soundcards, to your home stereo receiver! Adjustable from 89 to 95.5 MHz.

#EN-249-220 ..... $14.95 EACH

Weller Professional Irons

Weller

Perfect for a variety of electronic soldering work, this top quality iron features a long life, double coated tip and a quick change, plug-in heater element. Lightweight handle includes a comfortable cushioned grip. Net weight: 1/2 lb.

#EN-372-110 (25 Watt)	$30.90 (1-3)	$28.50 (4-UP)
#EN-372-112 (35 Watt)	$38.90 (1-3)	$34.95 (4-UP)

Peak Instrument Co.™

The Woofer Tester
QUICKLY AND ACCURATELY MEASURES: Fs, Qms, Qes, Qts, Vas, BL, Re, Le, SPL @ 1W/1m, Mmd, Cm, and Rm IN MINUTES!
◆ 30 DAY MONEY BACK GUARANTEE
◆ 1 YEAR WARRANTY ◆ SAME DAY SHIPPING

"The Woofer Tester"

Peak Instrument Co. proudly introduces "The Woofer Tester". Just ask any loudspeaker engineer, and they will tell that the only way to design enclosures of the correct size and tuning is to measure the Thiele-Small parameters for the actual drivers to be used. The reason? Manufacturers published specs can be off by as much as 50%! But until now, measuring the parameters yourself required expensive test equipment and tedious calculations, or super expensive measurement systems ($1,200 to $20,000). The Woofer Tester changes all that. Finally, a cost effective, yet extremely accurate way to derive Thiele-Small parameters, in only minutes! The Woofer Tester is a combination hardware and software system that will run on any IBM compatible computer that has EGA or better graphics capability and an RS232 serial port. The Woofer Tester will generate the following parameters. Raw driver data: Fs, Qms, Qes, Qts, Vas, BL, Re, Le, SPL @ 1W/1m, Mmd, Cm, and Rm. Sealed box data: Fsb and system Q. Vented box data: Fsb, ha, alpha, and Q loss. The Woofer Tester system includes hardware, test leads, serial cable, AC wall adaptor, detailed instructions, and software.

#EN-390-800 ..... $249.00 EACH

900 MHz Wireless Speaker System

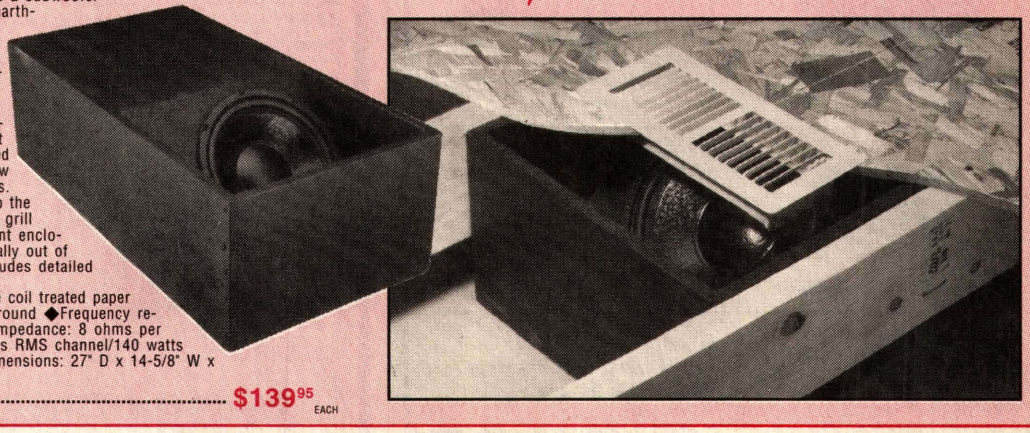
- ◆ 900 MHz technology sends signal up to 180 ft., through walls, floors and ceilings.
- ◆ Ideal for use as rear surround speakers or for adding wireless sound to every room in the house!
- ◆ Full range, bass reflex design with built-in high power, low distortion amplifier.
- ◆ Weather resistant cabinet for outdoor use.
- ◆ Selectable battery (six C size for each speaker) or AC operation, adaptor included. Built-in recharging circuitry for ni-cad batteries.
- ◆ System includes: 900 MHz transmitter, wireless speaker pair, AC adaptors, and all cables necessary to hook up system.
- ◆ Limited availability. ◆ Net weight 9 lbs.
- ◆ Frequency response: 20-18KHz.

#EN-319-030 ..... $169.95 EACH

Home Theatre In-Floor Subwoofer

Dayton Loudspeaker Co.®

To fully appreciate the potential of movie soundtracks, a dual voice coil subwoofer is a must! Many film special effects are extremely demanding in the low frequency range and require a subwoofer that can duplicate explosions, earthquakes, even the footsteps of Tyrannosaurus Rex! This subwoofer fits the bill by featuring a 10" dual voice coil woofer for true stereo operation and high pass filters for your main speakers. The most unique feature of this subwoofer is the fact that it is designed to be mounted in between the floor joists in new and existing home constructions. Simply mount the in-floor sub to the joists and mount a heat register grill above opening in subwoofer front enclosure. The subwoofer is now totally out of view and ready to rumble! Includes detailed installation manual.



Specifications: 10" dual voice coil treated paper cone woofer with poly foam surround ◆Frequency response: 30-100 Hz ◆Nominal impedance: 8 ohms per coil ◆Power handling: 100 watts RMS channel/140 watts max ◆SPL: 89 dB 1W/1m ◆Dimensions: 27" D x 14-5/8" W x 9" H ◆Net weight: 29 lbs.

#EN-300-445 ..... $139.95 EACH

VISA MasterCard DISCOVER NOVUS

◆30 day money back guarantee ◆$20.00 minimum order ◆We accept Mastercard, Visa, Discover, and company C.O.D. orders ◆24 hour shipping ◆Shipping charge = UPS chart rate + $1.90 ($5.00 minimum charge) ◆Hours 8:00 am - 8:00 pm ET, Monday - Friday ◆9:00 am - 5:00 pm Saturday. Mail order customers, please call for shipping estimate on orders exceeding 5 lbs. ◆Foreign destination customers please send $5.00 U.S. funds for catalog. ◆Quantity pricing available.

1-800-338-0531

340 E. First St., Dayton, OH 45402-1257
Phone: 937-222-0173 ◆ Fax: 937-222-4644
E-Mail: sales@parts-express.com

CIRCLE 262 ON FREE INFORMATION CARD

Network Service Tool Set

Popular installation and service tools for networks, modems and telephones. All hand tools are professional heavy duty type.

Use the compact tester on 10BASE-T (UTP & STP), thin Ethernet (BNC), 8-position Token Ring, AT&T 258A and EIA/TIA 568A/B. Automatically scans cables for continuity, wiring sequence and polarization. Tests STP cable ground. Testing installed cables is easy with Remote Terminator and gender changers (UTP and BNC). 9V battery included.

- Coax Stripping Tool, RG-58 & RG-59
- BNC Crimping Tool, RG-58 & RG-59
- Modular Cutting/Stripping/Crimping Tool (4, 6 & 8-Position)
- Multi-Network Cable Tester
- AC Receptacle Tester
- Cable Cutter

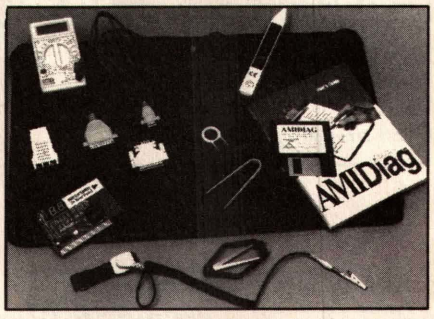
Order No. 55625 $197.00

PC Service Tool Set

Contains all tools needed to troubleshoot & service IBM-compatible PCs. Set includes:

- AMI Diagnostic Software
- POST Card
- Logic Probe
- Digital Multi-Meter
- AC Receptacle Tester
- Serial Adapter
- Serial & Parallel Loopback Connectors
- DIP IC Puller
- PLCC IC Puller
- Grounding Wrist Strap
- Key Top Puller

Order No. 55000 $198.00



PC Diagnostic Tool Set

- AMI Diagnostic Software
- POST Card

Order No. 55555 $89.00

Network Installation Tool Set

- Network Tool Set 55625 without the Multi-Network Cable Tester.

Order No. 55600 $99.00

Call for your FREE Catalog

Graymark®

P.O. Box 2015 Tustin, CA 92781
http://www.labvolt.com

CALL TODAY!

800-854-7393

VISA MasterCard AMERICAN EXPRESS Cards DISCOVER NOVUS

CIRCLE 329 ON FREE INFORMATION CARD

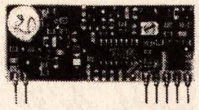
RF Data Modules

Transmitters

TXM-4XX-A..... $24.50
TXM-4XX-F..... $25.80

- ERP 0.25mW into 50Ω
- 3V(F), 5V(F) or 6-12V(A)
- 418 or 433.9Mhz FM
- simply add antenna, data, power
- Range up to 200m
- Analog or digital data i/p
- SAW controlled - stability

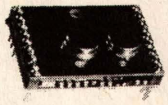
Receivers



SILRX-4XX-A..... $39.38
SILRX-4XX-F..... $41.92

- Only 21 x 47 x 5mm
- 13mA; 130uA on power save (100:1)
- Carrier detect o/p
- 418 or 433.9MHz FM Superhet
- SAW controlled - stability
- Analog or digital o/p
- Wide supply range 4,5-9V (A/F ver.)
- Fast enable time <3ms

Transceivers



BIM-4XX-F..... $87.36

- Only 23 x 33 x 11mm
- Up to 40,000bps of balanced code
- Up to 170m range.
- 5v operation
- 418 or 433MHz FM
- Direct interface to 5V CMOS logic
- Fast 1ms enable from power saving

RS232 Transceiver

59 x 40 x 14mm

CYPHERNET -RS232..... $139.30

- 3 wire RS232 interface
- Up to 38400 bps
- 418 or 433MHz FM. 7.5-15Vdc
- TX/RX LED indication
- Up to 150m range

ABACOM TECHNOLOGIES

Volume Discounts
Free Catalog Available
MasterCard / Visa

Tel: 416-242-3120
Fax: 416-242-2697
FaxBack: 416-242-3082

67 Hamptonbrook Dr • Weston • ON • M9P 1A2 • Canada

CONTROL
RELAYS • LIGHTS • MOTORS

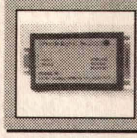
MEASURE
TEMPERATURE • PRESSURE • LIGHT LEVELS • HUMIDITY

INPUT
SWITCH POSITIONS • THERMOSTATS • LIQUID LEVELS

MODEL 30 ..... $79

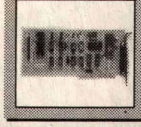
- PLUGS INTO PC BUS
- 24 LINES DIGITAL I/O
- 8 CHANNEL-8 BIT A/D/ IN
- 12 BIT COUNTER
- UP TO 14K SMP/SEC

MODEL 45 ..... $189



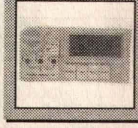
- RS-232 INTERFACE
- 8 DIGITAL I/O
- 8 ANALOG INPUTS
- 2 ANALOG OUTPUTS
- 2 COUNTERS-24 BIT

MODEL 100 ..... $279



- 12 BIT 100 KHZ A/D
- 4 ANALOG OUTPUTS
- 3 TIMER COUNTERS
- 24 DIGITAL I/O

MODEL 150-02 .... $179



- RS-232 INTERFACE
- TRMS, 20 AMPS
- 12 BIT A/D
- OPTO-ISOLATED
- COMPLETE DMM

MODEL 40 ..... $99

- RS-232 INTERFACE
- 28 LINES DIGITAL I/O
- 6 ANALOG INPUTS
- PWM OUTPUT

MODEL 70 ..... $239

- RS-232 INTERFACE
- 18 BIT A/D
- 5.5 DIGIT
- UP TO 60 SMP/SEC

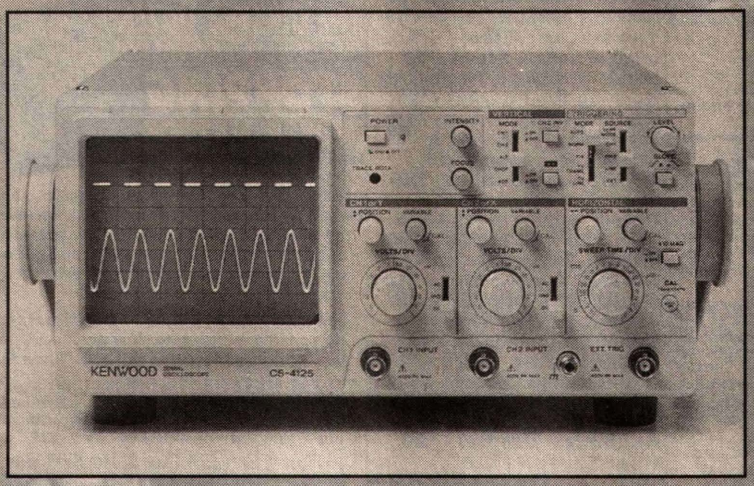
Prairie Digital, Inc.

PHONE 608-643-8599 • FAX 608-643-6754
846 SEVENTEENTH STREET • PRAIRIE DU SAC, WISCONSIN 53578

CIRCLE 324 ON FREE INFORMATION CARD

KENWOOD

...from the company you've been listening to for years...

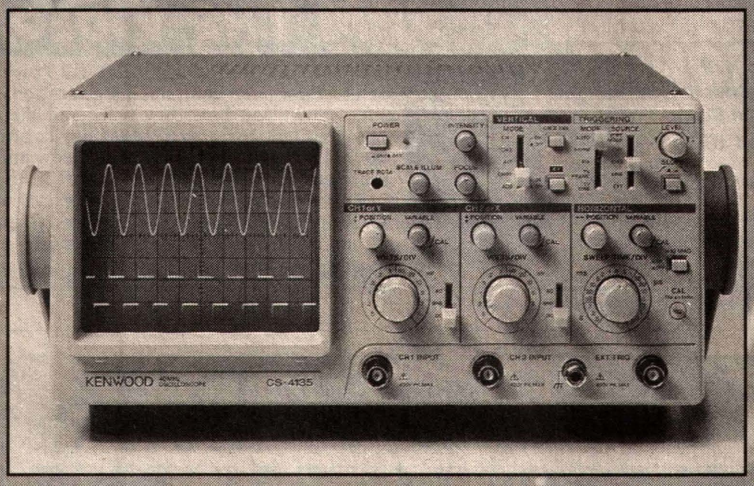


2-Channel, 20-MHz

CS-4125

Regular $595

Sale $389



2-Channel, 40-MHz Oscilloscope

CS-4135

Regular $855

Sale $685

Hybrid IC Technology is the Key to the High Quality and High Reliability at Low Cost!

- **FIX SYNCHRONIZATION** detects the trigger level automatically for the acquisition of stationary waveforms without complicated sync level adjustments.
- **VERT MODE TRIGGERING** enables the acquisition of stationary waveforms for both CH1 and CH2 even when the input signals to the two channels have different frequencies.
- **HIGH WITHSTAND INPUT** voltage of 400V (800Vp-p).
- **RELAY ATTENUATORS** are provided for reliable logic switchover.
- **SCALE ILLUMINATION** (CS-4135 only)
- **DIMENSIONS** (WxHxD): 300(343) x 140(150) x 415(430)mm ( ) including protrusion.
  WEIGHT: approx. 7.2kg (CS-4135) approx. 7kg (CS-4125)

VISA

MasterCard

AMERICAN EXPRESS Card

PRINT™ Products International

Call for your free 84 page test instrument catalog today!!!
8931 Brookville Road * Silver Spring, Maryland * 20910
**** Phone 800-638-2020 * Fax 800-545-0058 * email SMPRODINTL@AOL.com***

CIRCLE 264 ON FREE INFORMATION CARD

AUTOMATIC TELLER MACHINES

ATM crimes, abuses, vulnerabilities and defeats exposed! 100+ methods detailed, includes: Physical, Reg. E, cipher, PIN compromise, card counterfeiting, magnetic stripe, false front, TEMPEST, tapping, spoofing, inside job, vibration, pulse, high voltage - others, con jobs. Histories, law, security checklist, internal photos, figures. *Much more!* **$39.**

CELLPHONE MODIF. GUIDE

How cellphones operate and are modified. Vulnerabilities to hack attack and countermeasures. Details on programming NAMs, ESNs, etc (cloning), control data formats, computing encoded MINs, ESNs, SIDHs, operating systems, PROM programming, forcing ACK, test mode and resets, cable diagrams, scanning, tracking, scanner restorations, freq allocations, roaming, Step-by-steps to keypad-reprogram 100+ popular cellphones. *More!* **$49.**

PAGER / BEEPER MANUAL

How Pagers work, different types and uses, freqs, advantages over and uses with cellphones, and tips and tricks. How Pagers are hacked/countermeasures. And plans for a Personal Pocket Paging System (xmitter and receiver). *More!* **$29.**

PHREAKING CALLER ID & ANI

How they work and dozens of ways of defeating Caller ID, ANI, *69, *57, Call Blocking, *67 etc. Describes ESS, SS7, CN/A, CAMA, DNR, Diverters, Centrex - *more!* **$19.**

BEYOND VAN ECK PHREAKING

Eavesdropping on TV and computer video signals using an ordinary TV described in detail. Includes security industry reports. Range up to 1 KM. Plans include both the ours and the original Top Secret Van Eck designs! **$29.**

HACKING THE INTERNET

The latest tricks and methods being used on the Net to pirate software (warez) and the newest hacking websites. *Updated every two months.* Includes examples, countermeasures, password defeats, UNIX, Sprintnet, brute force methods, lots of tips, *and more!* **$25.**

COMPUTER PHREAKING

Describes in detail how computers penetrate each other, and how VIRUSES, TROJAN HORSES, WORMS are implemented. Dozens of computer crime and abuse methods and countermeasures. Includes disk filled with hacker text files and utilities, and the legendary FLUSHOT+ protection system . Internet advice, password defeats, glossary - *much more!* Manual + PC Disk! **$39.**

MANY MORE TITLES!

Hacking Fax Machines - $29
PBX Hacking - $19
Voice Mail Hacking - $29
Beyond Phone Color Boxes - $29
Hacking Answer. Machines - $19
The Hacker Files - $39
Internet Cons & Scams - $19
Internet Tracking & Tracing - $29
Hacking the Internet - $25
Cookie Terminator - $19
Beyond Van Eck Phreaking - $29
Casino Hacking - $25
Credit Card Scams - $29
Cons & Scams - $29
Polygraph Defeats - $25
By an Order of the Magnitude - $49
Ultimate Success Manual - $19
Stealth Technology - $19
Cryptanalysis Techniques - $29
Secret & Survival Radio - $19
Secret & Alternate IDs - $15
Rocket's Red Glare - $29
High Voltage Devices - $29
Mind Control - $29
Under Attack! - $29
Radionics Manual - $29
Heal Thyself - $19

SPECIAL PROJECTS

We will design & build just about anything! Ask for our free SP Application Form! Hardware now done as SPECIAL PROJECTS only

THE DIRTY-2 DOZEN!

24+ Disks. See CATALOG!

STOPPING POWER METERS

As reported on "60 MINUTES"!

All-new 6th Edition! Over 45 pages jam-packed with how devices can slow down (even stop) watt-hour meters - while loads draw full power! Device plugs into one outlet and normal loads into other outlets. Describes meter creep, overload droop, etc. **Plans only! $29.**

THE I.G. MANUAL: External magnetic ways (applied to meter) to slow down and stop power meters while drawing full loads. **Plans $25.**

KW-HR METERS: How watt-hour meters work, calibration, error modes (many), ANSI Standards, etc. **Demand and Polyphase Meters.** Experimental results to slow and stop meters by others. **$25.**

All 3 (above), *Only $59!* (Add $20 for SPM Video)

MAIL $3 FOR OUR LATEST CATALOG TO: ($1 w/order)

TOP SECRET CONSUMERTRONICS

2430 Juan Tabo, NE, #259, ABQ, NM 87112
P.O. Box 23097 ABQ, NM 87192

10% Off Orders Over $100!!

Order Today! 505-237-2073 (9-6, M-F)

Fax: 505-292-4078 (all hours, orders only) Web Adventure: www.tsc-global.com

Established in 1971. Featured on CBS "60 Minutes," Forbes, New York Times. Add $5 total S/H (US, Canada).
Sold for educational purposes only. Postal M.O. is fastest. VISA, MC OK. COD add $7.
See Catalog for LIMITED WARRANTY, SPECIAL PROJECTS and all other Policies

$29 SPM THE VIDEO!

Now its easier to learn about **KW-HR Power Meters** than ever before! This educational video shows you how they work and their anatomy. Demonstrates **SPMEM** device and external magnetic methods used to slow and stop meters! Hosted by a top expert in the field. From the novice to the pro, an excellent source of info on these exciting devices! Great in combo with our SPM related manuals!

Only $49 for SPM video + SPM manual!!

CIRCLE 226 ON FREE INFORMATION CARD

Weeder Technologies

Add $4 Ship/Hand US & Canada

FREE CATALOG!

VISA MasterCard

Pro-Kit

PO Box 2426, Ft. Walton Beach, FL 32549 850-863-5723

Stackable RS-232 Kits

Digital I/O - 12 I/O pins individually configurable for input or output. DIP switch addressable; stack up to 16 modules on same port for 192 I/O points. Turn on/off relays. Sense switch transistions, button presses, 4x4 matrix decoding using auto-debounce and repeat. **$32.00**

Analog Input - 8 input pins. 12-bit plus sign self-calibrating ADC. Returns results in 1mV steps from 0 to 4095. Software programmable alarm trip-points for each input. DIP switch addressable; stack up to 16 modules on same port for 128 single-ended or 64 differential inputs. **$49.00**

Home Automation (X-10) - Connects between a TW523 and your serial port. Receive and transmit all X-10 commands with your home-brewed programs. Full collision detection and auto re-transmission. **$38.50**

Caller ID - Decodes the caller ID data and sends it to your serial port in a pre-formatted ascii character string. Example: "12/31 08:45 850-863-5723 Weeder, Terry <CR>". Keep a log of all incoming calls. Block out unwanted callers to your BBS or other modem applications. **$34.50**

Touch-Tone Input - Decodes DTMF tones used to dial telephones and sends them to your serial port. Keep a log of all outgoing calls. Use with the Caller ID kit for a complete in/out logging system. Send commands to the Home Automation or Digital I/O kits using a remote telephone. **$33.50**

Telephone Call Restrictors

Two modes of operation; either prevent receiving or placing telephone calls (or call prefixes) which have been entered into memory, or prevent those calls (or call prefixes) which have "not" been entered.

Block out selected outgoing calls. Bypass at any time using your password. **$35.00**

Block out selected incoming calls. Calls identified using Caller ID data. **$46.00**

Phone Line Transponder

7 individual output pins are controlled with buttons 1-7 on your touch-tone phone. Automatically answers telephone and waits for commands. Monitor room noises with built in mic. "Dial-Out" pin instructs unit to pick up phone and dial user entered number(s). Password protected. **$49.00**

IR Remote Control Receiver

Learns and records the data patterns emitted by standard infrared remote controls used by TVs, VCRs, Stereos, etc. Lets you control all your electronic projects with your TV remote. 7 individual output pins can be assigned to any button on your remote, and can be configured for either "toggle" or "momentary" action. **$32.00**

DTMF Decoder/Logger

Keep track of all numbers dialed or entered from any phone on your line. Decodes all touch-tones and displays them on a 16 character LCD. Holds the last 240 digits in a non-volatile memory which can be scrolled through. Connect directly to radio receiver's speaker terminals for off-air decoding of repeater codes, or numbers dialed on a radio program. **$54.50**

!!!BROADCAST FARTHER!!!

The model 220 is an 80-110 MHz RF amplifier that connects to mono or stereo FM transmitters and produces a *powerful* 2-15 watt signal which could broadcast up to 5 miles or more! Requires 50-150 mW drive.

Step by step plans complete with part source information and antenna designs . . . *ONLY* **$14** PLUS $2 S&H NO C.O.D.'s

Progressive Concepts
BOX 586 STREAMWOOD, IL 60107
(630)736-9822 FAX:(630)736-0353
VISA MasterCard Discover

BUGGED??

EAVESDROPPING is unbelievably widespread! Electronic Devices with amazing capabilities can be monitoring your telephone and room conversations RIGHT NOW! Are you sure you're safe? FREE CATALOG tells you fast! Includes Free Bonus details on fantastic opportunities now open in Counter-Surveillance field. Exciting, immensely interesting and EXTREMELY profitable (up to $250 hr) full/part-time income. Call Now!

1-800-732-5000

CABLE TV CONVERTERS

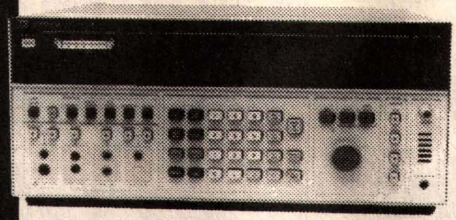
Equipment & Accessories
Wholesalers Welcome

Call C&D ELECTRONICS
1-888-615-5757 M-F 10a-6p

Quality Reconditioned TEST EQUIPMENT

Hewlett-Packard 3586B

Selective Level Meter, makes carrier measurements to 32.5 MHz, voice channel measurements from 50 Hz to 100 kHz.



$850.00

Hewlett-Packard 8901B

Modulation Analyzer, frequency range 150 kHz to 1300 MHz, measures RF frequency and RF power, completely automatic, has RF rear panel connectors. Other options available.

$5,200.00

Hewlett-Packard 8903B

Audio Analyzer, 20 Hz to 100 kHz, combines the functionability of a low-distortion audio source, frequency counter, high performance distortion analyzer, ac/dc voltmeter, and SINAD meter. Options available.

Special $3,250.00

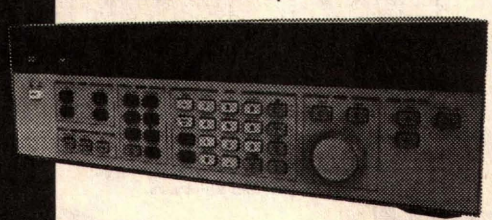
Hewlett-Packard 8657A Opt 002

Signal Generator, 100 kHz to 1040 MHz, 10 Hz resolution, +13 to - 143.5 dBm into 50Ω. Opt 002, RF connectors on rear panel.

$4,500.00

Hewlett-Packard 8642A

Synthesized Signal Generator, 100 kHz to 2.115 GHz, <-134 dBc/Hz SSB phase noise at 20 kHz offset, -100 dBc nonharmonic spurious, +20 dBm maximum output level.



$19,995.00

Hewlett-Packard 3335A

Synthesizer/ Level Generator, 200 Hz to 81 MHz, high spectral purity, precision amplitude control, 1 MHz resolution.

$6,250.00

Hewlett-Packard 8662A

Signal Generator, 10 kHz to 1280 MHz, output from +13 to -139.9 dBm, offers versatile phase-locked AM/FM using either internal 400 Hz and 1 kHz rates or externally applied modulating signals, either ac/dc coupled.

$28,700.00

Hewlett-Packard 8684B Opt 003

Signal Generator, 5.4 to 12.5 GHz, 10 MHz resolution with 3.5 digit LED display, +10 dBm to -130 dBm output power, AM, FM, and pulse modulation from internal or external source. Pulse modulation 10 Hz to 1 MHz.

$2,450.00

Hewlett-Packard 8447E

Amplifier, 100 kHz to 1.3 GHz, high power with +15 dBm output.Gain of 22 dB, ±1.5 dB.

$725.00

Tektronix 464

100 MHz Storage Oscilloscope, dual trace, 5 mV/div, variable persistence. Includes 2 probes.

$475.00

Tektronix 465B

100 MHz Oscilloscope, 5mV/div sensitivity, 2 nS sweep rate, delayed sweep, trigger view and beam finder. Includes 2 probes.

$675.00

Tektronix 466

100 MHz Storage Oscilloscope, dual trace, 5 mV/div, stored writing speed of 3000 div/µs variable persistence. Includes 2 probes.

$575.00

Tektronix 485

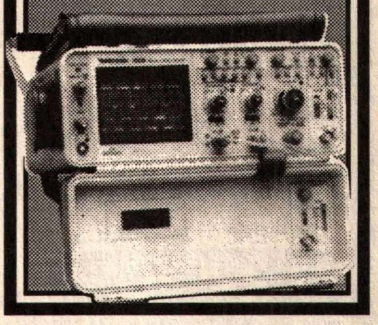
350 MHz Oscilloscope, dual trace, 5 mV/ div sensitivity, 1 ns/ div sweep rate, 3.0 div/ ns writing speed, selectable input impedance. Includes 2 probes.

$895.00

Tektronix 2336 Oscilloscope

Dc to 100 MHz bw, 5 mV/div to 5 V/ div, 5 ns/ div sweep rate, delta time on the flip top cover. Includes 2 probes.

Special $850.00



Hewlett-Packard 54111D

Digitizing Oscilloscope, 2-gigasamples/ second digitizing rate, 500 MHz bw, 8 kb memory per channel, up to 8 bits of vertical resolution, fully HP-IB programmable.

Special $3,900.00

Hewlett-Packard 8640B

Signal Generator, 0.5 to 512 MHz, -149 to +19 dBm RF output, phase locking and counter.

Special $1,250.00

EIP Microwave 545

Frequency Counter, 10 Hz to 18 GHz frequency range, 12 digit LED display, 15 mV sensitivity, 50Ω input.

Special $995.00

EIP Microwave 545A

Frequency Counter, 10 Hz to 18 GHz frequency range(3 bands), 12 digit LED display, time base: 10 MHz, aging rate <3x10-7/month, 50 Ω input.

Special $1,295.00

EIP Microwave 548

Microwave Frequency Counter, 10 Hz to 20.0 GHz, 12 digit LED display, source locking.

Special $2,500.00

(602) 483-6202 • Fax (602) 483-6403

14455 North 79th Street, Unit #C • Scottsdale, Arizona 85260

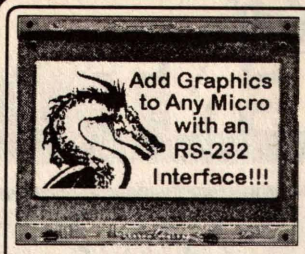
WANTED: USED TEST EQUIPMENT

DANBAR SALES COMPANY

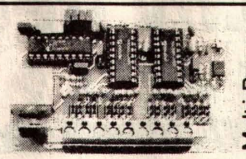
CIRCLE 235 ON FREE INFORMATION CARD

RS-232 Networkable Devices

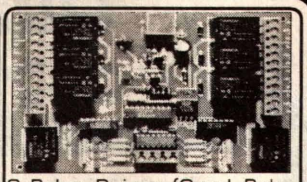
Only 2 Wires are Required to Operate Most NCD Devices from a Single RS-232 Serial Port



NEW: RS-232 programmable 256x128 Graphic Display Module w/software controlled Backlight. Upload up to 128 BMP Image Files, animate at 960 frames/second, 16 level gray-scale capability. Supports 32x16 Text overlayed with graphics. Documentation, Windows95 Setup Utility, and QBasic Example Software included. Counts as 2 Devices on the NCD RS-232 Network. Combine up to 8 LCDAs on a Single Serial Line or mix with our relay drivers and other devices. **Model described just $299. Two other models available for $199 and $249.**



8/16 Hobby Servo Controller. Futaba-J Compatible, Infrared Receiver Included with SV16 upgrade. Perfect in all animatronic applications.
SV8 Kit $39 Asm $54
SV16 Upgd Kit $19 Asm $29



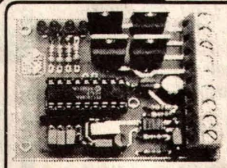
8-Relay Driver (Quad Relay Driver Available) includes 8 LED Status Lights. 12V Operation. Infrared Receiver. With Omron Mech Relays.
R8S (5A) Kit $89 Asm $139
R810 (10A) Kit $109 Asm $159

Includes Drivers in QBasic. Mac & Amiga Software Also Supported.

RS-232

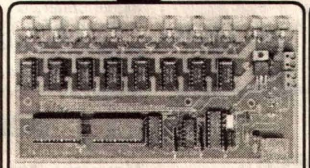
Combine 16 Devices in ANY Combination to Your RS-232 Port

National Control Devices
Contact Ryan Sheldon
Phone: (404) 244-2432
FAX: (417) 646-8302
Include $5 Shipping.
Visa/MC Accepted.
NCD, Box 384, Osceola, MO 64776

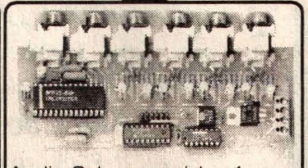


Leds Show Step Pattern.

High-Power Stepper Motor Controller for unipolar motors up to 12 volts 2 amps. Takes a step for every byte received. Control up to 16 steppers from 1 serial port.
STP Kit $24 Asm $39



Audio/Video Switcher: 8 Inputs, 2 Outputs, Infrared Controllable, Routes Any Input to Any Output. 12-18 volt DC operation. For Low-Power (Line-Level) Signal Switching.
AVS8 Kit $89 Asm $139



Audio Selector with 4 stereo inputs, 2 stereo outputs. Volume, Trebble, Bass, Fader. Controlled by infrared or RS-232 w/Windows95 software. Fully NCD Networkable.
NCD-ASP8X4 Asm $79

Infrared Transceiver for Remote RS-232 Communication with 16 IR Controllable Devices. **IRTR Kit $24 Asm $39**
RSB Serial Booster Gives your RS-232 Port the Power It Needs to Drive 16 NCD Devices. **RSB Kit $12 Asm $24**

On-Line Catalog: http://members.aol.com/ncdcat/ E-mail: ncdryan@aol.com

CIRCLE 316 ON FREE INFORMATION CARD

PCBoards

PCB Artwork Made Easy!

PRINTED CIRCUIT DESIGN SOFTWARE

For Windows and DOS

Layout - Autorouting - Schematic - Circuit Simulation

- **NEW 32 bit version available**
- **Ripup and Retry Router in Advanced Pkg.**
- **Copper Flooding for Building Ground Areas**
- **Gerber and Excellon Output**
- **Create Negative & Positive Printouts**
- **Create Single or Multi Layer Boards**
- **Create artwork from the Schematic**
- **Analog and Digital Simulation available**
- **Make boards up to 32" x 32"**
- **Parts Libraries - Silk Layers - Solder Mask**
- **Great for All Circuit Design Projects!**
- **For the Professional and Hobbyist!**

Download Demos from BBS (205)933-2954

Windows™ Version starts at **$149**

PCBoards Layout for DOS **$99**

Call or Write for Full Product Line, Prices & Free Demo

PCBoards
2110 14th Ave. South
Birmingham, AL 35205

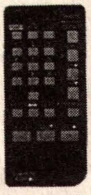
(800)473-7227
Fax (205)933-2954
Phone (205)933-1122

WHITE-STAR ELECTRONICS

TEL: 405-631-5153 FAX: 405-631-4788

CONVERTERS:	20	50	100+
Regal CR-83	45	39	35
Panasonic TZPC 175	75	69	65
Centurion CF 3000	65	59	55
Regal CR-83 Volumm	69	65	59

Call for FREE catalog.
405-631-5153



REMOTE CONTROL HAND UNITS:	20	50	100+
Jerrold Replaces: 400/450/550	4.95	4.50	4.25
Scientific Atlanta: 075/175/475	4.95	4.50	4.25
8600: On screen display	7.50	7.00	6.50
Pioneer: BR 81, 82	4.95	4.50	4.25
Panasonic: Call for model #	7.50	7.00	6.50
Zenith: All	4.95	4.50	4.25
Tocom: 5503-VIP, 5503-A	7.00	6.50	6.25
Universal: 4 in 1 R/M	7.50	7.00	6.50

Call for Oak, Hamlin, Regal-83, Regency, Texscan, and all others.

Tamper-Bit tools: (10-lot)
Jerrold compatible bits:
1/4" Stacom Bit $8.00
Oval Round D $20.00
Torx Bit:
Tocom T-8 ..... $8.00
Zenith T-10,T-15 ..... $8.00
Pioneer T-20 ..... $8.00
Scientific Atlanta T-20 ..... $8.00
Pio 63XX Oval $20.00
Bit Driver Handle $4.00

We carry most remote hand units. If you don't find the one you're looking for, we can locate for you.

Specializing in large quantities.

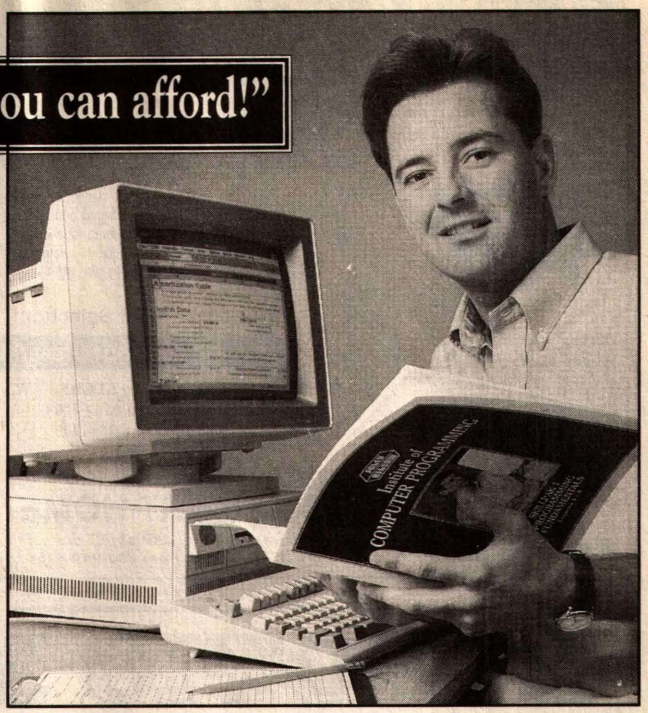
HOURS: Monday thru Friday 9 am to 5 pm Central Time.

Call for FREE catalog.
Email: wse405@aol.com

CIRCLE 314 ON FREE INFORMATION CARD

"Get the skills you need at a price you can afford!"

Earn up to $45 an hour or more as a skilled Computer Programmer.



Cash in on the explosion of opportunities. Start your new career or even open a business of your own as a highly-paid computer programmer.

Computer programmers today can almost write their own ticket to financial well–being and job satisfaction. Only Foley–Belsaw's unique in–home training programs can give you the skills you need at a price you can afford.

You'll learn the three hot computer languages — QBasic, C and Visual Basic. You'll even work with the hot new C++. With this easy–to–learn knowledge, you'll write your first QBasic program by the end of the first SkillPak of lessons. Soon you'll be programming sound and graphics, and even learning how to program for the Windows environment — the most popular application program today.

It's easy to cash in!

Look at some of the things professional computer programmers do. "Wrote a C program to clean up a WordPerfect file; edited the resulting file as data errors were found." This work would take a trained programmer less than five hours to complete, and they could make over $200 for the work. That's money you could be making — and soon — with training from the Foley–Belsaw Institute of Computer Programming.

Everything is included!

We provide you with all the materials you'll need to become a professional computer programmer. You'll receive 37 lessons, designed for you by the Foley–Belsaw Professional Programmer Staff. Other valuable materials include a *Programmer's Handbook*, Programmer's Examples on two 3.5 inch disks, Programmer's Flowchart Template, and a booklet, *Selecting the Right Computer*.

Other schools force you to buy a complete computer package as part of their training program. At Foley–Belsaw we understand that your needs as a programmer may not fit into a "one size fits all" approach. Why should you pay hundreds of dollars for a computer system that you may not need?

We'll tell you what you need to know so that when you're ready to buy your own computer, you can get the machine that fits your needs at the lowest possible price. That's the Foley–Belsaw way.

Get the free facts today.

Whether you want to change careers, have a profitable part-time job or start your own business, Foley-Belsaw Institute's new computer programming course is the first step. A profitable future in computer programming can be yours. Call or write today for a fact-filled information kit including a free copy of *Computer Programming — A Profitable Career In Your Spare Time*. See how easy it is to begin a money-making career as a sought-after computer programmer. Our free full-color information kit outlines the steps of the computer programming course and shows you everything you will receive as part of your training.

Mail this coupon or call today
Toll Free 1-800-487-2100!
Your free opportunity kit will be rushed to you!

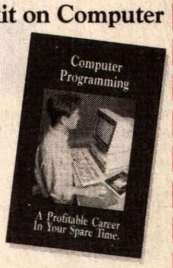
If coupon is missing, write to: Foley-Belsaw Company, 6301 Equitable Road, Kansas City, MO 64120

Call or complete & return this coupon to: Foley-Belsaw Institute,6301 Equitable Road, Kansas City, MO 64120

❑ **YES! Rush me a free information kit on Computer Programming right away. Dept. 35509**

Other career courses:

- ❑ Locksmithing, Dept. 13095
- ❑ Small Engine Repair, Dept. 52967
- ❑ Saw & Tool Sharpening, Dept. 21902
- ❑ VCR Repair, Dept. 62791
- ❑ Computer Repair, Dept. 64693
- ❑ TV/Satellite Dish Repair, Dept. 31562
- ❑ Gunsmithing, Dept. 92598
- ❑ Woodworking, Dept. 43834
- ❑ Upholstery, Dept. 81504
- ❑ Vinyl Repair, Dept. 71438
- ❑ Electrician, 95371
- ❑ Computer Specialist, Dept. 38337
- ❑ Networking Specialist, Dept. 39324



FOLEY BELSAW
Since 1926

I understand that there is ABSOLUTELY NO OBLIGATION and NO SALESMAN WILL CALL.

Name _____

Address _____

City _____ State _____ Zip _____

CIRCLE 335 ON FREE INFORMATION CARD

The World's Largest Source for Home Automation

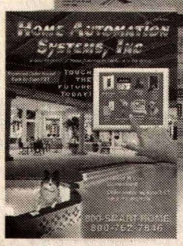
- The Best & Most Comprehensive Home Automation Catalog in the Industry.
- Best Customer Service & Technical Support

FREE 144 page full color catalog!

Thousands of hard-to-find automation, X-10 and wireless control products. Computer interfaces, software, development tools, lighting control, telephone systems, security systems, surveillance cameras, infrared audio/video control, home theater, touchscreen control, HVAC, pet care automation, wiring supplies, books and videos and much more!

World's Largest Selection!

Lowest Prices Guaranteed!



HOME AUTOMATION SYSTEMS, INC.
Questions: 714-708-0610 *Fax:* 714-708-0614
e-mail: catalog@smarthome.com
www.smarthome.com

Call for a *FREE* Catalog! 800-762-7846

800-SMART-HOME

Dealers/Resellers ask about our HASPRO Dealer Program 800-949-6255

5 Axis Robotic Arm Kit $195.00

Lynxmotion

Build your own functional Robotic Arm
The kit comes complete with all hardware, base enclosure, structural components, 6 Hitec servos, Mini SSC II servo controller, Quick Basic software and an illustrated assembly manual. This robotic arm can be controlled from any micro with a serial port! It makes an excellent addition to a small mobile robot base. It is a great foundation for artificial intelligence experiments and teaching motion control. Check out our web site for more information and other robot kits.

- **3 Axis Version $155.00**
- **Mobile Version $250.00**
- **Mobile Robots Book $48.00**

Quantity discounts available. $7.50 Shipping & Handling for USA, call for international and quantity shipping charges. IL residents add 6.25% sales tax to total.

Many more robot kits, ask for our free catalog!
Technical Service & Solutions
104 Partridge Road
Pekin, IL 61554-1403 USA

Tel: 309-382-1816
Fax: 309-382-1254
www.lynxmotion.com
jfrye@lynxmotion.com

AMERICAN LUNG ASSOCIATION®
The Christmas Seal People®

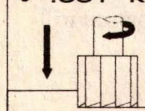
ROBOTIC MACHINING

ROUTE, MILL, DRILL, CARVE, ENGRAVE, PAINT . . . .
IN WOOD, PLASTIC, VINYL, PC BOARD, & LIGHT METALS!

- 4 MOTOR GANTRY MILL CONFIGURATIONS
- PC COMPUTER CONTROLLED CNC/DNC
- IMPORT/ EXPORT FILES TO OTHER CADS
- AUTO-BACKLASH COMPENSATION
- PRE-MACHINED HEAVY CASTINGS
- SIMULTANEOUS 3 AXIS MOTION
- FREE 3D CAD/CAM SOFTWARE
- AVAILABLE IN KITS OR ASSEMBLED
- EXPEDITE SERVICE ALSO AVAILABLE
- OPTIONAL ALUMINUM WAY COVERS
- .001" RESOLUTION / AMERICAN MADE

STARTING AT $695.00

3 AXIS UNITS
FROM 12" X 12" TO
66" X 66" MACH. AREA



http://www.uscyberlab.com

U.S. CYBERLAB, INC. 14786 SLATE GAP RD., WEST FORK, AR 72774

CALL NOW FOR INSTANT SPECS 501-839-8293 24 HR. FAX-BACK

Use Your PC to Monitor and Control Your Environment

PC Host Adapter

HA3

RS232 to 1-Wire™ protocol host adapter interface. Converts standard PC serial port to a 1-Wire™ network. All interface components are contained inside the DB9 shroud. The HA3 supports all Point Six Products.
- No external power required.
- Includes OneSix™ DDE Server Software.
- Connects to 9 pin RS232 port on the PC.
- 2000 ' Network and 200 1-Wire™ devices.
- Weight 0.5 lb.
- One-year warranty.

OneSix™ DDE Server

A software server driver for Windows® 95, 3.1 and 3.11 that allows easy interface of 1-Wire™ devices and Point Six products to applications via DDE links. This eliminates the need for low level device communication programming.
- Searches network, adds and auto configures all new devices found.
- Copy and paste links to Office® products like Excel®, Word® and many other DDE capable applications.
- Works with HMI interface software such as Wonderware®, LabView®, and TestPoint®.
- Includes complete help. • Includes an HA3 Host Adapter.
- Weight 0.5 lb. • One-year warranty.

1-Wire™ Probes

STP010

Our probe designs are based on 1-Wire™ protocol devices. All probes are multi-dropable and supported by OneSix™ DDE Server Software.
- Digital Data Output.
- Built-in multi-drop controllers. • All Data is CRC16 error checked.
- Unique device addressing.
- Calibration data stored in internal ROM memory.
- No external power required.
- Standard Temperature Range -30 to +182°F.
- Requires Host Adapter or existing network.
- Weight 1.0 lb. • One-year warranty.

Very Low Cost Per Point Temperature Monitoring

Item	Description	Price
HA3	Host Adapter	69.95
ONESIX	DDE Server Software Driver	69.95
T1SS	Single Channel Digital I/O Solid State Relay Backplane	29.95
STP010	Standard Temperature /W 10' Lead	14.95
STP025	Standard Temperature /W 25' Lead	16.95
PRP001	Pressure Probe 0-30 PSI Absolute	159.95
PHP001	pH Probe 0-14pH	159.95
HMP001	Humidity Probe 0 - 100% RH	159.95
FCP001	Force Probe 1500gm	179.95
DS1820	Digital Thermometer Chip	3.49

Two wire multi-drop network based on Dallas Semiconductor 1-Wire™ Protocol

MasterCard VISA

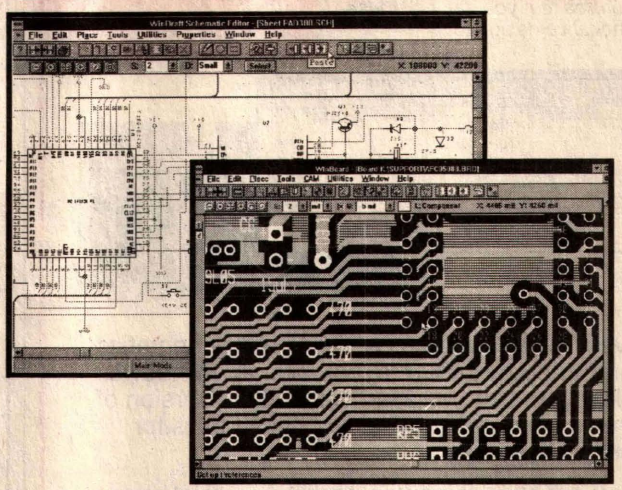
http://www.pointsix.com

Example: 25 Digital Thermometer Chips, 1000ft Cat-5 Cable, HA3 Host Adapter, OneSix™ DDE Server Software Driver, and Windows® Monitoring Application all for less than $10 per point.

Point Six, Inc. To Place An Order Contact Us At 138 E. Reynolds Road Lexington, KY 40517 Phone: 606-271-1744 FAX: 606-271-4695 E-Mail: sales@pointsix.com

Electronic CAD for Windows

Professional Windows EDA tools at an affordable price with powerful features to make designing faster. WinBoard PCB layout delivers sophisticated interactive routing for complex designs, plus it has the tools needed for high-speed circuits, analog, RF and SMT designs.



WinDraft® Schematics

- Use True-Type fonts. Quickly copy and paste into other applications.
- Supports hierarchical designs, electrical rules checking, Annotation & Bill of Materials.
- Thousands of library parts and symbol editor included.

WinBoard™ PCB layout

- Supports 16 layers, multiple copper pours, and advanced features for RF designs.
- SMD & through hole library with on-line graphical editor.
- CAM outputs include BOM, in-circuit test, NC Drill, Gerber, Pick & Place, & Advanced Design Rule Checking (DRC).

With our unique ***pin capacity*** versions you only pay for what you need. You choose the base configuration to suit your needs today, and expand that configuration to handle increased pin capacity as your design requirements change.

WinDraft 2.0 Available Now

$ 250 **WinDraft or WinBoard - P650**
$ 495 **WinDraft or WinBoard - unlimited**

$ 895 **WinBoard P650 with CCT Specctra® autorouter.**

Thousands of satisfied customers are using this new generation of powerful and affordable Windows EDA tools from Ivex. Your satisfaction is guaranteed!

World Wide Web: http://www.ivex.com

Information and free evaluation version is available on the Ivex WW Web, FTP and BBS.

Tel: (503) 531-3555
Fax: (503) 629-4907
BBS: (503) 645-0576

IVEX™ DESIGN INTERNATIONAL

Ivex Design International. 15232 NW Greenbrier Parkway. Beaverton, Oregon 97006. USA.

ADV2_1

CIRCLE 319 ON FREE INFORMATION CARD

RAIN FOREST RESCUE:™ TO HELP SAVE THE BIRDS OUTSIDE YOUR WINDOW

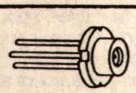
Support Rain Forest Rescue. Help put a stop to the destruction of the planet's rain forests.

To contribute to Rain Forest Rescue, call 1-800-222-5312

The National Arbor Day Foundation

MEREDITH INSTRUMENTS

5420 W. Camelback Rd #4
Glendale, AZ 85301
(602) 934-9387



New Visible Laser Diodes **$10.00**

New He-Ne tubes from **$10.00**

New Green Laser Heads **$150.00**

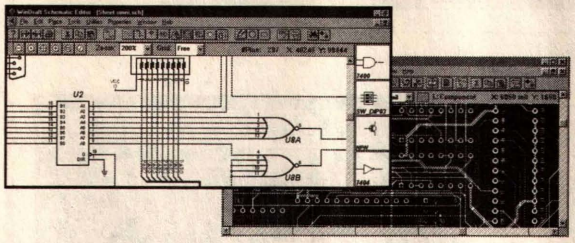
Check out our complete line in our **Free catalog** on Lasers and Optics

http://www.mi-lasers.com

Electronic CAD

You could pay up to ten times more for many of the same features that you get with these innovative design tools.

$29.95



Over 25,000 people use WinDraft Schematics and WinBoard PCB layout tools for Windows. Now, you can buy a special 200 pin version of these best selling Windows based tools for only $29.95 each.

You get everything you need to complete your circuit designs at an affordable price and it's easy to expand as your designs grow.

For the name of your local NTE distributor, Call 1-800-683-6837, or browse the internet www.ivex.com/nte.html

IVEX DESIGN INTERNATIONAL

EPROM+

A DEVICE PROGRAMMER FOR BENCH AND FIELD

SUPPORTS ALL STANDARD PARTS! USES PARALLEL PRINTER PORT!

FIRST GENERATION EPROMS (24 PIN) 2708, TMS2716*, 1702*, 25XX
SECOND GENERATION EPROMS (24, 28, 32 PIN) 2716 - 27C080 (8 MEG)
*16 BIT EPROMS** (40, 42 PIN) 27C1024 - 27C160 (16 MEG)
FLASH EPROMS (32 PIN) 28F, 29C, 29EE, 29F FAMILIES PLUS BOOT BLOCK
EEPROMS/NVRAMS (24-32 PIN) 28C04 - 28C010, X2210/12, ER5901, 12XX
*SERIAL EEPROMS** (ALL 8 PIN PARTS) 17, 24, 25, 35, 59, 80011, 85, 93, ER1400
*BIPOLAR PROMS** (16-24 PIN) 74SXXX AND 82SXXX FAMILIES
*MICROCONTROLLERS** (ALL FAMILIES) 874X, 875X, 87C5XX, 87C75X, 89C5X 89CX051 68HC705, 68HC711, PIC12XXX - 16XXX, 17C4X PLUS FLASH AND 14000

- ◆ READ, PROGRAM, COPY COMPARE, FILE LOAD/SAVE (PLUS MORE!)
- ◆ FULL SCREEN EDITOR W/25 COMMANDS + BYTE & WORD MODES
- ◆ SOFTWARE RUNS UNDER DOS, WIN3.1/95 ON ANY SPEED MACHINE
- ◆ MADE IN THE USA • 30 DAY MONEY BACK GUARANTEE *ADAPTER REQUIRED DIAGRAMS INCLUDED

SYSTEM INCLUDES: PROGRAMMING UNIT, SOFTWARE, PRINTER PORT CABLE, PRINTED MANUAL AND POWER PACK

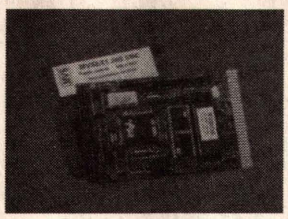
ANDROMEDA RESEARCH
P.O. BOX 222
MILFORD, OHIO 45150
(513) 831-9708 FAX (513) 831-7562

$289

$5.00 SHIPPING • $5.00 C.O.D.
VISA • MASTERCARD • AMEX

386 MINI-PC $83

1K PRICE
EVAL $295
8088 $27



includes:
-5 Serial,3 Parallel (32bit max)
-Up to 8 meg ROM (27C080)
-32k RAM exp. to 64Mbyte
-Battery backed RT Clock
-LCD and Keyboard ports
-IRQ x15, DMA x2, TIMER x4
-On-board LED display
-Industry Standard PC Bus

Perfect when a full-size PC is too large, expensive, or power hungry. A fully functional single board computer, needs only program and power source. Runs DOS / WINDOWS. Use Turbo C, BASIC, MASM. All utilities to do this included.

A to D D to A CONVERTERS

For PC or SBC
8,12,16 bit resolution
up to 24 channels
starting at $21 OEM (1k)
eval kit $75

$95 UNIVERSAL PROGRAMMER

FLASH, EEPROM, NVRAM, EPROM up to 8 meg (27C64-080). Adapters for micros, PLCC, etc. Parallel port version for notebook. FAST AND EASY TO USE.

LOW COST... LOW POWER...

LOW RISC!

QTY 1K PRICE
$1.99
EVAL KIT 7.00

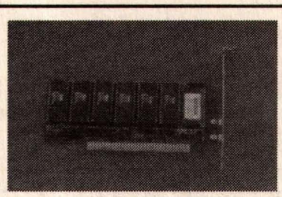
LOWER COST, FASTER, EASIER TO PROGRAM SINGLE CHIP COMPUTER

COMPARE:	16C54	MV1200
OEM (1K) PRICE	$2.57	$1.99
RS232 PROGRAM DOWNLOAD	NO	YES
SINGLE CHIP OPERATION	NO	YES
BUILT-IN BASIC	NO	YES
EEPROM DATA MEMORY	NONE	64
PROGRAM MEMORY	768 OTP	1K FLASH
MATH REGISTERS	1	32
MAX INSTRUCTIONS / SEC	5M	20M
MAX COUNTER BITS	16	18
INPUT / OUTPUT BITS	12	15
A TO D COMPARATOR	NO	YES
HARDWARE INTERRUPTS	NONE	3

PINOUT:

RESET	1	20	VCC
PD0	2	19	PB7
PD1	3	18	PB6
XOUT	4	17	PB5
XIN	5	16	PB4
PD2/INT	6	15	PB3
PD3	7	14	PB2
PD4/TMR	8	13	PB1/AD1
PD5	9	12	PB0/AD0
GND	10	11	PD6

- LONG WORD INSTRUCTION - FRIENDLY SYMMETRIC ARCHITECTURE -



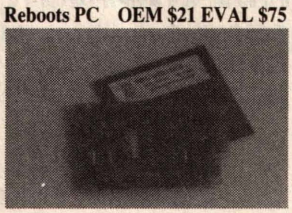
PC SOLID STATE DISK

$21 OEM (1k) eval kit 75.00
FLASH / RAM / EPROM
256K-16M PCMCIA/DIPS

No More Hangups...

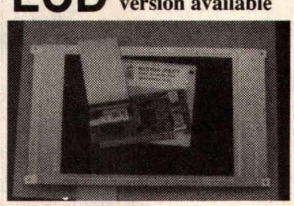
PC WATCHDOG!

Reboots PC OEM $21 EVAL $75



VGA LCD

640x480 controller for PC or SBC $27 oem $95 eval combo LCD/CRT version available



visit our web site: www.star.net/people/~mvs

MVS BOX 850
MERRIMACK,NH 03054
(508) 792-9507

MVS

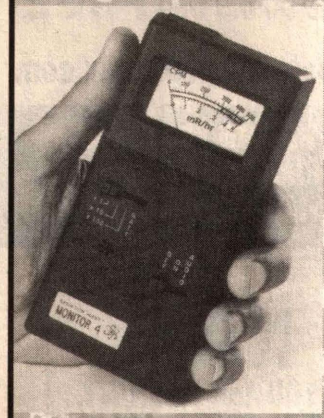
5yr Limited Warranty
Free Shipping
Hrs: Mon-Fri 10-6 EST

CIRCLE 323 ON FREE INFORMATION CARD

RADIATION® A•L•E•R•T

QUALITY AT YOUR FINGERTIPS

The easy to build Monitor 4 kit is a cost effective way for you to survey for radiation

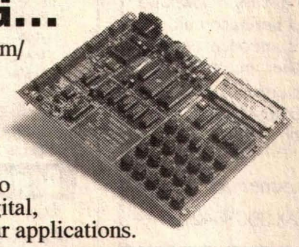


BUILD OR BUY YOUR OWN GEIGER COUNTER

The finished kit is a sturdy general purpose Geiger counter capable of detecting alpha, beta, gamma, and x-rays. Kit price $160.00

S.E. International, Inc.
P.O. Box 39
Summertown, TN 38483-0039
Tel: 800-293-5759 Fax:931-964-3564
E-mail: seiinc@usit.net Website: seintl.com

Learn MICROCONTROLLERS EMBEDDED SYSTEMS and PROGRAMMING...



...with the AES learning system/ embedded control system. Extensive manuals guide you through your development project. All programming and hardware details explained. Complete schematics. Learn to program the LCD, keypad digital, analog, and serial I/O. for your applications.

THREE MODELS AVAILABLE. Choose from an Intel 8051, Intel 8088, or Motorola 68HC11 based system. All models come with:

• 32K Byte ROM, 32K Byte RAM • 2 by 16 Liquid Crystal Display • 4 by 5 Keypad • Digital, Analog, and Serial I/O • Interrupts,timers, chip-selects • 26 pin expansion connector • Built-in Logic Probe • Power Supply (can also be battery operated) • Powerful ROM MONITOR to help you program • Connects to your PC for programming or data logging (cable included) • Assembly, BASIC, and C programming (varies with model) • Program disks with Cross Assembler and many, well documented, program examples • User's Manuals: cover all details (over 500 pages) • Completely assembled and ready to use • Source code for all drivers and MONITOR • Optional Text Book

Everything you need. From $279.
Money Back Guarantee

Call for Free Info Pack, or see WEB at http://www.aesmicro.com
714-550-8094, FAX 714-550-9941

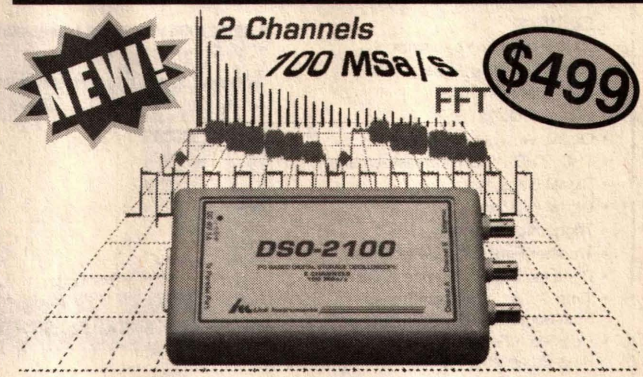
AES Advanced Educational Systems

Call 1-800 -730-3232

AES 575 ANTON BLVD., SUITE 300, COSTA MESA, CA 92626, USA

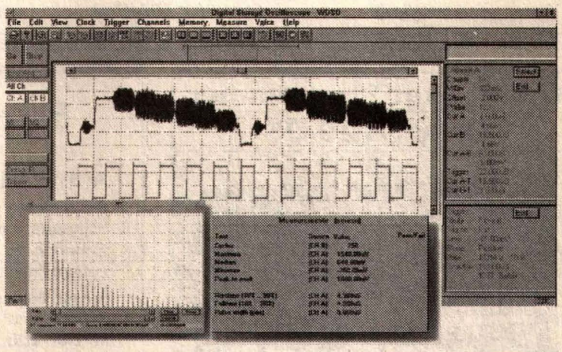
Digital Oscilloscopes

100 MSa/s Parallel Port Based DSO

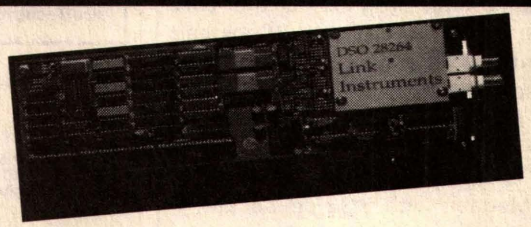


- **2 Ch.** Digital Oscilloscope
- **100 MSa/s** Max Single-Shot Rate on Both Channels
- **60MHz** Input Bandwidth
- **32K** Samples Per Channel
- Optional FFT Spectrum Analyzer*, Advanced Math* and TV Line Trigger**
- IEEE Pulse Parameter Measurements
- One touch **Auto-Setup**
- Advanced Pulse Triggering*
- Hands-Free Voice Control
- Easy to use Windows and DOS Software Included
- **Parallel Port** Interface to Laptop or Desktop PC
- Small and Lightweight (9 oz and 6.3" x 3.75" x 1.25")
- **Free** Demo Software on Web

For **$499** you get the model **DSO-2102S Oscilloscope**, Probes, Interface Cable, Power Adapter, and Windows and DOS Software.
*DSO-2102M **$599** **TV-Line Module **$149**



DSO w/Logic Analyzer (ISA based)



- **200 MSa/s** Max Single-Shot Sample Rate
- **2** Oscilloscope Channels
- **8** Logic Analyzer Channels
- **10** Channels Simultaneously
- **125 MHz** Single Shot Bandwidth
- Up to **128K** Samples/Channel
- FFT Spectrum Analyzer included

DSO-28264 (10Ch, 200MSa/s, 64k) **$1999**
DSO-28464 (20Ch, 200MSa/s, 64k) **$3799**
All prices include Probes and Software

Link Instruments (973) 808-8990
369 Passaic Ave ⟨ Suite 100 ⟨ Fairfield, NJ 07004
www.LinkInstruments.com/en5 ⟨ Email: Sales@LinkInstruments.com

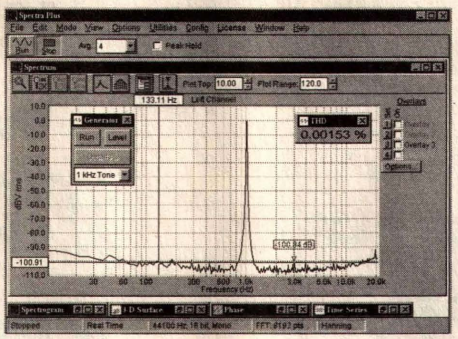
CIRCLE 330 ON FREE INFORMATION CARD

PC PLACE

Turn Your Multimedia PC into a Powerful Real-Time Audio Spectrum Analyzer

Features

- 20 kHz real-time bandwith
- Fast 32 bit executable
- Dual channel analysis
- High Resolution FFT
- Octave Analysis
- THD, THD+N, SNR measurements
- Signal Generation
- Digital Filtering
- Triggering, Decimation
- Transfer Functions, Coherence
- Dynamic Data Exchange (DDE)
- Time Series, Spectrum Phase, Spectrogram and 3-D Surface plots
- Real-Time Recording and Post-Processing modes



Applications

- Distortion Analysis
- Frequency Response Testing
- Vibration Measurements
- Acoustic Research

System Requirements

- 486 CPU or greater
- 8 MB RAM minimum
- Win. 95, NT, or Win. 3.1 + Win.32s
- Mouse and Math coprocessor
- 16 bit sound card

Priced from $299

(U.S. sales only – not for export/resale)

Professional Quality Sound Cards Available...Call

DOWNLOAD FREE 30 DAY TRIAL!

www.telebyte.com/pioneer

PHS Pioneer Hill Software
24460 Mason Rd. N.W.
Poulsbo, WA 98370

Spectra Plus 4.0
Affordable Signal Processing Software

Sales: (360) 697-3472 *Fax: (360) 697-7717* *e-mail: pioneer@telebyte.com*

POPTRONIX®

Online Edition

We're on the web **FREE**

http://www.poptronix.com

WE'RE WITH YOU EVERY DAY 24 HOURS A DAY! DROP IN! WE'D LOVE TO HAVE YOU VISIT!

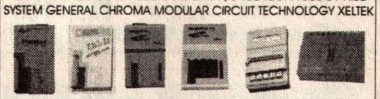
NAVY

YOU AND THE NAVY. FULL SPEED AHEAD.

1-800-USA-NAVY

PROGRAMMERS OVER 50 MODELS

ADVANTECH EETOOLS NEEDHAMS DATA I/O ICE TECHNOLOGY HILO SYSTEM GENERAL CHROMA MODULAR CIRCUIT TECHNOLOGY XELTEK



PROMAX EMP-20 MEGAMAX MEGAMAX4 SIMM/SIP TESTER EMUPA

CALL ADVANTECH LABTOOL	599 EETOOLS SIMMAX
629 ICE TECH MICROLV	795 CHROMA SIMM/SIP
650 EETOOLS ALLMAX +	359 MOD-MCT-EMUPA/R
409 EETOOLS MEGAMAX	279 MOD-MCT-EMUP/R
509 EETOOLS MEGAMAX4	49 EPROM 1G TO 512K
369 XELTEK SUPERPRO II	69 EPROM 1G TO 1MEG
409 XELTEK SUPERPRO II P	99 EPROM 4G TO 1MEG
249 XELTEX SUPERPRO L	199 EPROM 16G TO 1 MEG
165 XELTEK ROMMASTER II	89 EPROM 1G TO 8MEG
479 MOD-MCT-EMUPA	129 EPROM 4G TO 8MEG
739 STAG ORBIT-32	250 EPROM 8G TO 8MEG

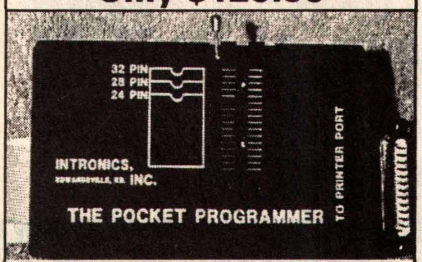
LABTOOL48 MICROMASTER SUPERPRO ALLMAX PLUS ROMMASTER2

General Device Instruments

Sales 916-393-1655 Fax 916-393-4949 BBS 983-1234

Web www.generaldevice.com E-Mail icdevice@best.com

The Pocket Programmer
Only $129.95



The portable programmer that uses the printer port of your PC instead of a internal card. Easy to use software that programs Eprom, EEprom, Flash & Dallas Ram. 27(C) / 28(C) / 28F / 29F / 29C & 25XX series from 16K to 8 Megabit with a 32 pin socket. Adapters available for Pic, PLCC, 5-Gang, 874X, 875X MCU's, 40-Pin X 16 & Serial Eprom's, and Eprom Emulator to 32K X 8.

Same Name, Address & Phone # for 13 Years... Isn't it Amazing ?

Intronics, Inc.
Box 13723 / 612 Newton St.
Edwardsville, KS 66113 Add $4.75 COD
Tel. (913) 422-2094 Add $4.00 Shipping
Fax (913) 441-1623 Visa / Master Charge

Filter Wiz v2.0

ACTIVE FILTER design software for Windows. Provides mastery of lowpass, highpass, bandpass and bandstop filters. Enhance critical signal components while controlling noise and other interference.

Meets the needs of both novice and professional designer. Standard (LE) version $89, PRO version $199.

Download: http://www.schematica.com

sales@schematica.com FAX:250-642-2644

FerretTronics at www.FerretTronics.com

FerretTronics
3801 N. Jupiter Rd, Suite 8B
Richardson, TX. 75082

FT639 Servo Controller Chip

FT639
Designed for RC servos found at most hobby stores.
Only an 8 pin count.
Independently control 5 servos.
Controlled via a 2400 serial line.
Two modes - 256 positions in approximately 90 or 180 degrees

FT629 Switch Feedback Chip

FT629
Receive feedback from 5 switches.
Feedback via 2400 baud line.

Build your own Robotic, animatronics, or research project.
Controlled by a PC, Mac, HP48, or any device with serial port.
Free software and Java Programing Kit available for download from website.
ONLY 19.95 For Both Chips.
Call 1-800-228-3404 for orders only.

FEATURING

NEW PRODUCTS!

IEEE-1284 ELECTRONIC SWITCH

2-COMPUTERS
TO
1- PARALLEL PRINTER
-NO POWER REQUIRED-
-SIMPLE PUSH-BUTTON OPERATION-
-ALL PORTS DB-25 FEMALES-

THIS BOX FEATURES FILE TRANSFER CAPABILITY. SIMPLY PUSH A BUTTON AND LINK THE TWO COMPUTERS TO TRANSFER DATA!

DS-252-1284..... $24.99 EA

COMPUTER POWER SUPPLIES

230 WATT MINI SIZE-UL/CSA
PS-245..... $20.50 EA

250 WATT MINI SIZE -UL/CSA
PS-247 ..... $27.35 EA

CANNED AIR

12oz. CAN
COMPRESSED AIR
GREAT FOR CLEANING
ELECTRONIC EQUIPMENT!
TM-AIR..... $6.50 EA

DC-DC CONVERTER

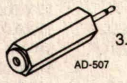
800 ma CAR ADAPTER
7- DETACHABLE PLUGS
-REGULATED OUTPUT-
FOR RADAR DETECTORS, PHONES, CD PLAYERS, ETC.
TM-354..... $8.00 EA

AUDIO ADAPTERS

S-VIDEO/ADB COUPLER F/F

AD-506..... $3.95 EA

3.5MM COUPLER F/F-STEREO
AD-503..... $1.50 EA



3.5MM JACK TO 2.5MM PLUG -STEREO
AD-507..... $2.70 EA

DUAL RCA F/F COUPLER- GOLD
AD-555..... $3.95 EA

Roger's Systems Specialist

800-366-0579

"We Have Great Connections"

Computer - Communications
Network - Audio - Video

www.rogerssystems.com

Order On-Line! **Call for a FREE catalog!**

Specials!

Microphone

Stick-on monitor or clip on or stick onshirt 6 ft. cord; condenser mic.

#TM-MIC-2
$2.00 each

CD Jewel Case

Replacement for original

#TM-CD1
$.40 each

Parallel Port

DB25 Female to 26 pin socket

#CN-702 $.50 each
100/$.40

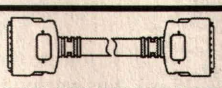
COLORFUL MOUSE PADS

MANY COLORS AND PATTERNS- HEAVY DUTY!
#TM-PAD $1.00 each

Special I-EEE 1284 Printer Cable

10' Bi-Directional
DB25 Male to
Mini Centronic 36
A.K.A. type "A" - "C"
#CC-PR6-BIMIN
$.89 each

SCSI



SCSI 1 TO SCSI 1 CABLE

50 pin Centronics
male to male
6 ft.
#CC-676
$7.00 each

SCSI 2 TO SCSI 1 CABLE

HD50 to Centronics 50
male to male
6 ft.
#CC-686
$19.00 each

SCSI 3 TO SCSI 1 CABLE

HD68 to 50 pin centronics
male to male
6 ft. w/ thumbscrews
#CC-687-6TS
$37.00 each

SCSI 3 TO SCSI 3 CABLE

HD68 to HD68
male to male
6 ft. w/thumbscrews
#CC-693-6TS
$39.00 each

SCSI 2 TO SCSI 2 CABLE

HD50 to HD50
male to male
6 ft.
#CC-678-6
$36.00 each

SCSI 2 TO SCSI 3 CABLE

HD50 to HD68
male to male
6 ft. w/ thumb screws
#CC-692-6TS
$36.00 each

CABLES

DB25 TO SCSI 1 CABLE

DB25 to 50 Centronics
male to male
6 ft.
#CC-670
$4.00 each

DB25 TO SCSI 2 CABLE

DB25 to HD50
male to male
6 ft.
#CC-671-6
$20.00 each

DB25 TO SCSI 3 CABLE

DB25 to HD68
male to male
6 ft.
#CC-697-6TS
$39.00 each

All cables available in 3 ft. lengths!

TM-FAN-PENT2

FANS

FOR COOLING
PENTIUM II
PROCESSORS
-BALL BEARING-
-PLUGS ONTO
MOTHERBOARD-
TM-FAN-PENT2
$16.00 EA

HARD DISK DRIVE COOLER

-FITS IN FRONT OF HARDDRIVE,
FITS IN 5 1/4" BAY-
TM-FAN-HDD
$14.00 EA

MONITOR CABLES

6' HD15 TO DB13W3
MALE TO MALE
FOR **SUN** MONITORS
CC-VGA-DB13W3
$39.00 EA

6' HD15 TO 5 BNC
MALE TO MALE
CC-VGA-5BNC
$12.00 EA

Local 805-295-5577 **Remember, We Have Great Connections...For You!** **FAX 805-295-8777**

$10.00 minimum order required • Add $4.50 shipping for pre-paid orders
California residents add 8.25% tax • eMail Sales@RogersSystems.com
Call for quantity discounts • No out of state checks accepted • Most orders shipped same day
24895 Avenue Rockefeller, Valencia, CA 91355

CIRCLE 311 ON FREE INFORMATION CARD

ABC ELECTRONICS 315 7TH AVE N. MPLS. MN. 55401
(612)332-2378 FAX (612)332-8481 E-MAILSURP1@VISI.COM
WE BUY TEST EQUIPMENT AND COMPONENTS.
VISIT US ON THE WEB AT WWW.ABCTEST.COM

TEK 7B15 1 GHZ DELAYING TIME BASE	$250.00	TEK 2245 100 MHZ 4 CHANNEL O-SCOPE	$800.00
TEK 1470 NTSC GENERATOR	$500.00	TEK 7A19 600 MHZ SINGLE TRACE AMPLIFIER	$150.00
TEK 7A26 200 MHZ DUAL TRACE AMPLIFIER	$75.00	TEK 7B85 400 MHZ DELAYING TIME BASE	$125.00
TEK 7904 500 MHZ MAIN FRAME	$250.00	TEK 7S11 SAMPLING PLUG IN	$200.00
TEK 7S12 GENERAL PURPOSE SAMPLER	$350.00	FLUKE 95 SCOPE METER NO PROBES	$600.00
TEK 453 50MHZ OSCILLOSCOPE	$200.00	TEK 146 NTSC GENERATOR	$500.00
DRANETZ 626 DISTURBANCE ANALYZER	$1500.00	HP 8182A 50 MHZ PATTERN GENERATOR	$800.00
GENRAD 1657 RLC BRIDGE	$750.00	PHILLIPS PM3296 400 MHZ OSCILLOSCOPE	$1000.00
TEK 7D20 PROGRAMMABLE DIGITIZER	$500.00	EMI SCR 7.5-300 7.5V 300A POWER SUPPLY	$500.00
TEK 465 100 MHZ OSCILLOSCOPE	$400.00	HP 8558B SPECTRUM ANALYZER	$1500.00
TEK 465B 100 MHZ OSCILLOSCOPE	$450.00	WAVETEK 175 WAVE FORM GENERATOR	$500.00
TEK 2335 100 MHZ OSCILLOSCOPE	$800.00	WAVETEK 157 PROG. WAVE FORM SYNTH.	$250.00
TEK 2215 60 MHZ OSCILLOSCOPE	$350.00	RACAL DANA 1901 100 MHZ COUNTER	$200.00
TEK 496P 1KHZ-1.8GHZ SPECTRUM ANALYZER	$5000.00	VALHALLA 2790B SYSTEM INTERFACE	$150.00
BRADLEY 132 SCOPE CALIBRATOR	$700.00	GENRAD 1683 RLC BRIDGE	$300.00
PHILLIPS PM3350A 60 MHZ DIG.STORAGE SCOPE	$1000.00	HP 3455A MULTIMETER	$300.00
HP 8601A 110 MHZ SWEEP/SIGNAL GENERATOR	$400.00	HP 3456A MULTIMETER	$450.00
FLUKE 5200A AC CALIBRATOR	$1500.00	FLUKE 77 DMM "NEW"	$120.00
HP 54100A 1GHZ DIGITIZING OSCILLOSCOPE	$3000.00	TEK TM504 4 SLOT POWER FRAME	$125.00
HP 8170A LOGIC PATTERN GENERATOR	$150.00	HP 4955A PROTOCOL ANALYZER	$500.00
SYSTRON DONNER DPSD 50	$500.00	MAGTROL 4614 POLYPHASE POWER ANLZR.	$300.00
LEADER LSG215A 125 MHZ SIGNAL GENERATOR	$700.00	TEK CT-5 HIGH CURRENT TRANSFORMER	$500.00
TEK TM506 POWER MODULE	$150.00	FLUKE 8502A 6.5 DIGIT DMM TRUE RMS	$350.00
PHILLIP PM5785 PULSE GENERATOR	$750.00	FLUKE 1952 80 MHZ COUNTER	$200.00
WAVETEK CT235 AC/DC CURRENT PROBE	$120.00	TEK 475 200MHZ SCOPE	$500.00

No Calories. No Fat. No Cholesterol.

...NO KIDDING. Our free Consumer Information Catalog serves up over 200 free and low-cost government booklets you can really sink your teeth into. Perk up your appetite with subjects like saving money, buying a house, educating your children, getting federal benefits, eating right, staying healthy, and many more.

So come 'n get it! Whatever your taste, you can feast on the free Catalog. It's filled with plenty of satisfying booklets. Just call toll-free **1-888-8 PUEBLO.**

Or get a bite on the Consumer Information Center website: **www.pueblo.gsa.gov**

U.S. General Services Administration

ULTIMATE HOME SHOP

Complete tools for metal & woodworking

Starting at **$995** — Smithy — Easy to use Versatile Affordable

FREE CATALOG

Call **1-800-345-6342** or write: Smithy Dept. ENS, PO Box 1517 Ann Arbor, MI 48106-1517

Do You Repair Electronics?

Repair Databases for TV, VCR, Monitor, UL Audio, FCC, and more.

- Over 76,000 records
- Private user forums
- Live on-line chat rooms

RepairWorld.com

Electronix Corp 1 Herald Sq. Fairborn, OH 45324 (937) 878-9878

CABLE TV CONVERTERS

Equipment & Accessories Wholesalers Welcome

Call C&D ELECTRONICS
1-888-615-5757 M-F 10a-6p

Call Today And SAVE! **Unbeatable PRICES!**

CABLE TV

DESCRAMBLERS
CONVERTERS · FILTERS
VIDEO STABILIZERS

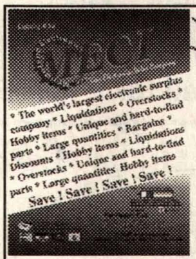
FREE ➤ 30 Day Trial
FREE ➤ Product Catalog
FREE ➤ 1 Year Warranty

100% MONEY BACK GUARANTEE

Let us point you in the right direction ...

Arrow Technologies
Omaha, Nebraska

TOLL FREE
888-554-ARROW
888-554-2776



Free Catalog

If you are not getting this catalog you are missing out on some of the best deals in electronics today! We have thousands of items ranging from unique, hard-to-find parts to standard production components. Call, write, or fax today to start your free subscription to the most unique catalog in the industry, filled with super values on surplus electronic and hobbyist type items. If you have a friend who would like to receive our catalog, send us their name and address and we will gladly forward them a complementary 100 page catalog.

Why pay more? Call today.

MECI

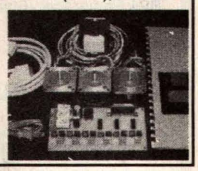
340 East First Street Fax Order Line
Dayton, Ohio 45402 1-800-344-6324

Order Toll-Free
1-800-344-4465

3 Axis Motion Control System
Complete, ready to run
$ 255.50 + 12.00 S/H

Build or adapt CNC mills, CNC routers, Robots, Etc. Includes: 3 Stepping motors (70 oz/in 200 steps/rev). External board (connects to parallel port of a PC). Power supply. Cables, Manual and the MAXNC drive software, with linear, circular and helical interpolation, acceleration deceleration, full contouring, 'G' code programming, screen plot, code generation from CAD (CAM), and more.

For more information, phone or write to:
MAXNC
6730 West Chicago
Suites 2 & 3
Chandler, AZ 85226
Ph (602) 940-9414
Fax (602) 940-2384



C COMPILER $49.00
for PIC microcontrollers

Supports PIC16C55x, 16C6x, 16C62x, 16C8x, 16C92x microcontroller families. Based on **ANSI C** standard. Supports arrays, unions, structures, pointers, strings, function calls, if, for, switch, while, interrupt vectors, in-line assembler code, 8 & 16 bit variables, etc. Outputs Intel Hex format and assembly code. Code optimizer included. Excellent development tool!

732-873-1519 fax: **732-873-1582** e: **grichrc@aol.com**
Grich RC Inc. 120 Cedar Grove Ln, Ste 340, Somerset NJ 08873

CIRCLE 251 ON FREE INFORMATION CARD

Any waveform you want!

Starting at

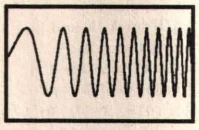
$795

Quantity 1

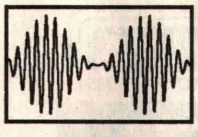
Money back guarantee

- **Synthesized Signal Generator**
  Clean sinewaves DC-20 MHz with .001% accuracy! .1 Hz steps. DC Offset. RS232 remote control.
- **Arbitrary Waveform Generator**
  40 Megasamples/Second. 32,768 points. 12 bit DAC
- **Function Generator**
  Ramps, Triangles, Exponentials & more to 2 MHz!
- **Pulse Generator**
  Digital waveforms with adjustable duty cycle

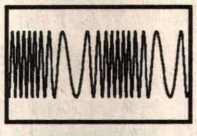
Telulex Inc. model SG-100



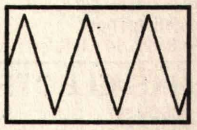
DC to 20 MHz linear and log sweeps



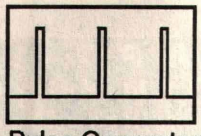
Int/Ext AM, SSB, Dualtone Gen.



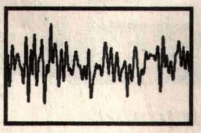
Int/Ext FM, PM, BPSK, Burst



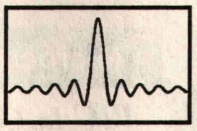
Ramps, Triangles, Exponentials



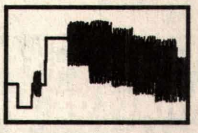
Pulse Generator



Noise



Arbitrary Waveforms



Unlimited Possibilities!

Telulex Inc.

2455 Old Middlefield Way S **Tel** (650) 938-0240 **http://www.Telulex.com**
Mountain View, CA 94043 **Fax** (650) 938-0241 Email: sales@Telulex.com

CIRCLE 318 ON FREE INFORMATION CARD

PIC'n Books

LEARN ABOUT PIC16/17 MICROCONTROLLERS

EASY PIC'n
Beginner

- Programming techniques
  - Instruction set
  - Addressing modes
  - Bit manipulation
  - Subroutines
  - Sequencing
  - Lookup tables
  - Interrupts
- Using a text editor - source code
- Using an assembler
- Timing and counting
- Interfacing - I/O conversion
- Lots of examples

$29.95

PIC'n Up The Pace
Intermediate

- Serial communication
  - PIC16 to peripheral chips
  - PIC16 to PIC16
- Serial EEPROMS
- LCD interface
- Scanning keypads
- D/A conversion
- Sensors - analog voltage output
- A/D conversion
- Math routines
- Decimal interface
- PIC16F84 EEPROM data memory
- Lots of circuits and code

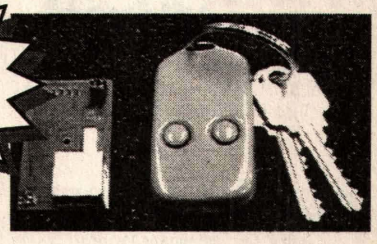
$34.95

+ $4 s/h in US for one book, $5 both books
VISA, MC, AMEX, MO, Check
CA residents please add 7.25% CA sales tax
PIC is a trademark of Microchip Technology Inc.

SQUARE 1 ELECTRONICS

P.O. Box 501, Kelseyville, CA 95451
Voice (707) 279-8881 FAX (707) 279-8883
Web Site: http://www.sq-1.com
E-Mail sqone@pacific.net

NEW! µLINK™ SERIES



Send us email or a SASE for your FREE catalog

µLink™ Infrared Remote Control System

- 4 Channel IR keychain Transmitter (pcb 1.1"x 1.2") IRTX4-A
- 4 Channel IR Receiver (pcb 1.1"x 1.9") IRRX4-A
- Each receiver can LEARN up to 4 transmitters.
- Each transmitter can have a different access level.
- User selectable receiver output modes.
- Up to 9m Range. Great for security and hobby applications.
- RX and TX IC's available.

Only $39.95/pair + S&H, additional IRTX4-A units $19.95

SURFACE MOUNT KITS:
- Pager Decoder Interface
- Garage Door Openers
- Many IR and RF kits!

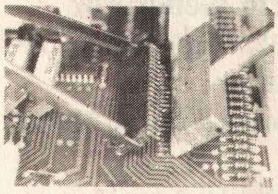
Wireless SMT RF kits:
- XTAL mics, 3 bands!
- Quality LC tuned FM mic
- Phone transmitters

Orders: 1-800-417-6689 Mon-Fri 9AM-6PM ET
visa/mastercard/money orders
email: iecorp@i-e-c.com
web: http://home.earthlink.net/~iecorp
IEC♦PO Box 52347♦Knoxville TN 37950

COPYRIGHT ©1998 International Electronics Corp.

7 SECOND IC REMOVER

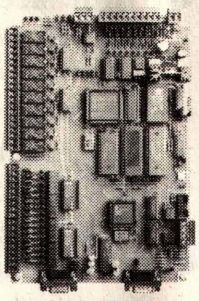
Remove 100's of good IC's per hour
Won't damage IC's or circuit boards



8 Desoldering Tools
(Remove 6 thru 40 pin IC's) ..... **$ 89.95**
10 Desoldering Tools
(Remove 6 thru 64 pin IC's) **$114.95**

FRANKS ELECTRONICS
P. O. BOX 357 — GLEN, MISS. 38846
Orders By Mail Only. No COD's.

SC552ES CONTROLLER



- 80C552 @ 22MHz
- Enhanced BASIC Language
- 6"x9" circuit board
- 10 5A relay outputs
- 3 LED or logic outputs
- 16 opto-isolated inputs
- 8 ch. 10 bit analog inputs
- 2 ch. 8 bit analog outputs
- Real Time clock/calendar
- 128K Static RAM
- 128K FLASH memory
- 256 byte serial EEPROM
- 3 serial ports (RS232/485)
- IIC bus expansion
- Plug-on I/O terminal blocks
- Single 12Vdc operation

APPLICATION READY ONLY $349.95

SYLVA CONTROL SYSTEMS

519 Richard Street, Thunder Bay, Ontario, Canada P7A 1R2
Ph. 807-768-2487 Fax 807-767-0587
www.sylvacontrols.com info@sylvacontrols.com

Make your own circuit boards at home!!

Don't project-board your electronics circuits, Afford-A-Board them!! Our complete line of circuit board manufacturing equipment lets you create professional single or double-sided circuit boards in your own home. We manufacture affordable, developing, etching and stripping tanks. Afford-A-Board is your source for 2-sided photo-sensitive copperclad board.

12x12 FR4 1 oz. DS $15.99

Call for our low, low pricing on film, chemicals and drill bits.

Afford-A-Board
P.O. Box 32613
Kansas City, MO 64171
Tel: (913) 385-1843
Fax: (913) 895-9330
(888) 454-1017
VIsa/AMEX/MC/Cash COD/MO

Printed Circuits in Minutes Direct From LaserPrint!

8 1/2" x 11"
* Or Photocopy
**Use standard household iron or P-n-P Press.

1. LaserPrint*
2. Press On**
3. Peel Off
4. Etch

Press-n-Peel®

Use Standard Copper Clad Board
20 Shts $30/ 40 Shts $50/ 100 Shts $100
Visa/MC/PO/Ck/MO $4 S&H
Techniks Inc.
P.O. Box 463
Ringoes NJ 08551
ph. 908.788.8249 fax 908.788.8837
http:\\chelsea.ios.com\~techniks
Retail Dealer Inquires Invited

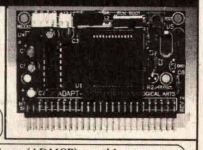
Microcontroller Tools

PIC In-Circuit Emulator
for the PIC16Cxx from $295
PIC Programmer $155
80C552 (8051) Development Training System $235
68HC11 SBC $120
ROMY-16 EPROM Emulator from $195
Universal Microprocessor **Simulator/Debugger** (including **Assembler**, and **Disassembler**) $100 each CPU

J&M **Microtek, Inc.**
83 Seaman Rd, W Orange, NJ 07052
Tel:(973)325-1892 Fax:(973)736-4567
http://www.jm-micro.com

ADAPT-11
68HC11 Modules for Solderless Breadboards

- miniature 2.0" by 2.8" module
- plugs vertically into solderless breadboard for easy development
- BOOT/RUN switch for easy programming via PC serial port
- all I/O lines on dual row connector



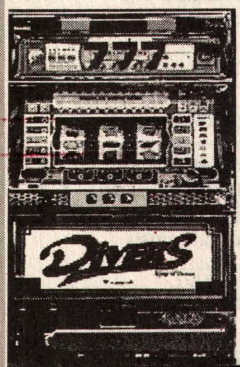
Complete modular prototyping system! Expansion accessories available!

For just U$74.95, our Starter Package (AD11SP) provides everything you need to get going fast! Now you can harness the power of the popular 68HC11 in your projects! Includes ADAPT-11 with 68HC811E2, providing 2K EEPROM (re-programmable), 8 channel 8-bit Analog-to-Digital Converter (ADC), hardware timers, counters, interrupts, Serial Peripheral Interface (SPI), Serial Communications Interface (SCI), & more! On-board RS-232 interface (cable included), 5-volt regulator, 8MHz crystal, reset circuit, and convenient program/run switch. Comes with non-commercial versions of *HC11 Assembler, BASIC, & C, as well as handy utilities & example code. Includes Motorola 68HC11 Pocket Programming Reference Guide and manual with schematic. All you need is a PC to write & program your software, a DC power supply, and a solderless breadboard (or protoboard) to build your application circuits on (or use our modular accessories).

Visa • MasterCard • AmericanExpress • Discover

TECHNOLOGICAL ARTS
309 Aragona Blvd., Suite 102, Box 418, Va. Beach, VA 23462
1644 Bayview Avenue, Box 1704, Toronto, ON M4G 3C2
voice/fax:[416] 963-8996 www.interlog.com/~techart

Slot Machines $ 449.00



Free Shipping
Slot Machine Demo Video $ 5.99
40 - Minutes
33" High 20" Wide 14" Deep
Brochure $ 1.00
Magic Box
Test Chips
Filter Kits

Notch Filters

Video Media www.nutnet.com
P.O. Box 93/6025
Margate, Fl. 33093
(954)-752-9202

FRIENDLY LITTLE
MICRO CONTROLLER

$149 (single)

...packs a ***MEAN*** punch
a.k.a. "Steroid Stamp"

- 39 I/O + 8 A/D (10 bit)
- 128K SRAM + 128K Flash
- LCD/Keypad Interface
- Fast 16 bit Motorola CPU
- Affordable C Compiler
- Comprehensive s/w Library

Intec Automation Inc.
www.islandnet.com/~iii
v: 250-721-5150
fx: 250-721-4191

THE COLLECTED WORKS OF MOHAMMED ULLYSES FIPS

#166—By Hugo Gernsback. Here is a collection of 21 April Fools Articles, reprinted from the pages of the magazines they appeared in, as a 74-page, 8½ × 11-inch book. The stories were written between 1933 and 1964. Some of the devices actually exist today. Others are just around the corner. All are fun and almost possible. Stories include the Cordless Radio Iron, The Visi-Talkie, Electronic Razor, 30-Day LP Record, Teleyeglasses and even Electronic Brain Servicing. Get your copy today. Ask for book **#166** and include **$16.00 (includes shipping and handling)** in the US and Canada, and order from **CLAGGK Inc., P.O. Box 4099, Farmingdale, NY 11735-0793.** Payment in US funds by US bank check or International Money Order. Allow 6-8 weeks for delivery.

MA05

MY PERSONAL GUARANTEE with the New & Improved DEN-ON SC7000Z

More Vacuum

Lane Norman - Norman's Electronics Inc. Atlanta GA 404-451-5057
A cost effective solution to desoldering equipment at less than half the price of most equipment. It's performance is ASTOUNDING.

Mike Murphy - Service Center -Van Nuys CA 818-785-7805
The single best investment of repair equipment we've made. It outperforms all other desoldering tools we've used. Easier to use and least expensive.

Quicker Vacuum

George McKinzie - MCK Electronics, Inc. - Nisswa MN - 218-963-4400
A marvelous instrument, a real time saver and has a tremendous vacuum for it's size. The size and portability is also a great advantage.

Dick Manning - Dicks Electronics - Hartland WI 414-367-8339
The ease & speed of component removal greatly increases productive time. The SMD kit makes SMD removal a breeze, even for inexperienced Techs.

George Hefner - Hefner Electronics - Coleridge NE 402-283-4333
Being a one-men service center, I hesitated to spend the money on a desoldering tool , however all that changed when I nearly ruined a $400 computer logic board. It has cut my desoldering time by 50%

FREE TRIAL
Available on Request

Sale Price $395.00

Price includes stand worth $25.00 one extra filter, and two tip cleaners.

Don Cressin - Certified Electronics Service - Ellicott City MD 301-461-8008
We have obtained excellent results with the SC7000Z including repairing high density U/V tuners. It is one of the best purchases we have made.

Doug Pettit - LuRay Electronics - LuRay VA 703-743-5400
We found that the SC7000Z not only saves money vs. wick, but saves valuable time in troubleshooting. It allows you to be more accurate in removing SMD's.

Randy Whitehead - Service West - Salt Lake City UT 801-262-4069
My Techs thought it would be a waste. I bought one anyway after a demo. My Techs then fought over it. Now we have three. It is the Best desoldering tool we have ever used.

Check us out on the WEB
http://www.heinc.com
Order from web site for 5% discount

Service Managers, Owners, CEO's, CFO's

My personal guarantee to you is that after 90 days of ownership, if you are not convinced that you have made a wise decision for your business with the purchase of the SC-7000Z desoldering tools, your investment will be fully refunded with the return of the merchandise. Now you have no reason not to try it.

Jerry Howard, President.

New Specifications

- **Voltage**——AC100V,120V,230V,50/60Hz
- **Power Consumption**——120W
- **Pump**——Diaphragm Type
- **Motor Output**——12W
- **Vacuum Attained**——**650mmHg**
- **Temperature Range**——300°C—**500°C** (572°F—**932°F**)
- **Air Flow Rate**——15 Liter/Minute (Open)
- **Heater**——100W (Ceramic)
- **Control System**——Feed Back Zero Cross-over Type
- **Net Weight**——420Grams
- **Max.Temp. of Hot Blow**——400°C
- **The Most Cost Effective Desoldering Tool in the World.**

- Totally Self Contained diaphragm vacuum pump and AC motor for high vacuum suction or reversible hot air blow for SMD removal.
- 100Watt Ceramic heater with zero-crossover switching heater control circuit which prevents spikes and leakage currents.
- Unique patented long lasting filter cartridge design. Solder builds up on easily cleaned baffle, while air flows around the outside of baffle.
- Totally ESD Safe. The housing contains carbon and the tip is at

Visa - M/C - Discover - American Express - Terms to Qualifying Companys
30 Day Money Back Total Satisfaction Guarantee - One Year Parts and Labor Warranty

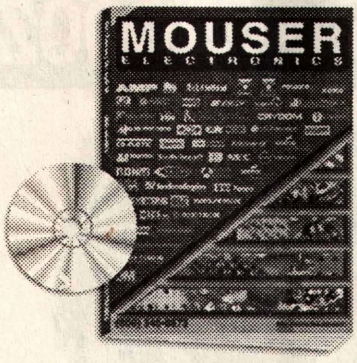
HOWARD ELECTRONIC INSTRUMENTS INC
Your Desoldering Specialists

Toll Free U.S. and Canada
1-800-394-1984

Web Site www.heinc.com
E-Mail sales@heinc.com
International (316) 744-1993
or Fax (316) 744-1994

CIRCLE 331 ON FREE INFORMATION CARD

ELECTRONIC COMPONENTS



Visit our web site!
www.mouser.com

FREE catalog is available on the internet, CD-ROM, or in paper!

• 70,000+ Products • 145 Suppliers
• Same Day Shipping • No Minimum Order

800-992-9943
817-483-6828 Fax: 817-483-0931
www.mouser.com catalog@mouser.com
958 North Main St., Mansfield, TX 76063

CIRCLE 325 ON FREE INFORMATION CARD

Call For FREE Catalog!

CABLE TV BONANZA

LOW PRICES! GREAT SERVICE!

FULL VIEW CABLE BOXES
WHOLESALE PRICES!
30 Day Free Trial!
1 Year Guarantee!
• VIDEO STABILIZERS–Removes video tape copy protection
• TEST CHIPS, DEVICES, FILTERS AND ACCESSORIES
FREE BULLET BUSTER with cable box purchase (REG.$9.95)
Anyone implying theft of service will be denied assistance
N.S. INTERNATIONAL
OPEN DAILY 9am - 11pm (EST) 1-800-449-9189 C.O.D. or Credit Cards

Crystal-Controlled UHF Micro Video Transmitter

Surface mount module transmits high-resolution COLOR or B&W video for over a quarter mile!

only $59.95

WHY PAY MORE?
- 100mW RF output
- Operates on 9-12VDC
- Transmits 2 days on 9V battery
- Receive on cable TV channel 60
- Auto bias, sync & polarity protection
- 30 DAY MONEYBACK GUARANTEE!

Includes schematic diagram and detailed information on how it works!
All orders shipped by UPS & include regular updates on NEW high-tech products, plans & kits!
VISA, M/C, CK, MO, COD. Add $4.50 S&H.
DECO, Box 607, Bedford Hills, NY 10507
ORDER 1-888-DECO-1998 24 HOURS
TECH / INFO 914-243-0346 PHONE / FAX

MO-TECH DISTRIBUTORS
YOUR MIDWEST PANASONIC CONVERTER WHOLESALER

PANASONIC

TZPC1453G2
"Top of the line converter" featuring sleep timer, parental lock, standard/HRC switchable, last channel recall, favorite channel memory, and 83 channel capable.

TZPC1003
One of our best selling converters featuring sleep timer, parental lock, last channel recall, favorite channel memory, and 80 channel capability.

TZPC175DG2
Our "Top of the line" converter with volume control. Featuring sleep timer standard/HRC switchable, parental lock, last channel recall, favorite channel memory and 83 channel capable.

Phone (810) 739-2710
Fax (810) 739-3517

The Electronic Experimenter's Journal

It's part catalog, part magazine and part data book with kits, parts, plans, articles, and application notes.

Call for your FREE copy today

Debco Electronics
4025 Edwards Rd.
Cincinnati, OH 45209
1 800 423-4499

BEST DEALER PRICING!

CABLE DIRECT

CONVERTERS • FILTERS
DESCRAMBLERS

IMPROVE YOUR IMAGE WITH VIDEO STABILIZERS

FREE CABLE TV CATALOG!

100% MONEY BACK GUARANTEE!

30 DAY FREE TRIAL!

Now you can tune-in your favorite cable TV programming and SAVE $100'S - EVEN $1000'S on premium CABLE TV EQUIPMENT.

MODERN ELECTRONICS
1-800-906-6664
2609 S. 156TH CIRCLE • OMAHA, NE 68130
http://www.modernelectronics.com

Cable T.V.
Converters & Equipment

Lower Prices
Dealer Discounts
30-Day Money back
1-year warranty
MC, Visa, AE, COD

No Florida Sales
www.cable4you.com
1-(800) 888-5585

SURVEILLANCE

The Latest High Tech
Professional Electronic Devices

Our latest catalog offers a HUGE selection of surveillance, counter-surveillance/privacy devices: hidden video equipment, pinhole cameras $149.00, telephone recording systems: 12-Hour $139.00 16-Hour $199.00 touch tone decoders, scanners, bug/phone tap detectors, voice disguisers, telephone scramblers, locksmithing tools, and more.

Catalog $5.00

SPY OUTLET
P.O. Box 337, Buffalo, NY 14226
(716) 695-8660/(716) 691-3476

Make Life Easy!

Program these PICs in BASIC:

12C671, 12C672, 14000, 16C554, 16C556, 16C558, 16C620, 16C621, 16C622, 16C62, 16C63, 16C64, 16C65, 16C71, 16C72. 16C73, 16C74, 16C84, 16F83, 16F84, more.

BASIC makes it easy for you to program the fast and powerful Microchip PIC microcontrollers.

- Expanded BS1/2 compatible instruction set
- True compiler provides faster program execution and longer programs than BASIC interpreters

new! PicBasic Pro Compiler - $249.95
PicBasic Compiler - $99.95
EPIC Pocket PIC Programmer - $59.95
PICProto Boards - $9.95 to $17.95

microEngineering Labs, Inc.
Box 7532 Colorado Springs CO 80933
(719) 520-5323 fax (719) 520-1867
http://www.melabs.com

ALL ELECTRONICS CORPORATION

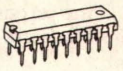
QUALITY PARTS

FAST SHIPPING

DISCOUNT PRICING

CALL, WRITE, FAX or E-MAIL For A Free 96 Page CATALOG.
Outside the U.S.A. send $3.00 postage.

Stepper Motor Controller IC



E-Lab # EDE-1200
Controller IC for unipolar stepper motors. Designed to interface a logic-level signal to a stepper motor. Also capable of running independently (self-clocking). Allows for half-stepping and directional control. TTL/CMOS compatible inputs. TTL-level outputs. 18 pin DIP package. 5 vdc operation. Works for most unipolar stepper motors. Includes specs and hook-up diagram.
CAT# EDE-1200 $12.50 each

PRICE REDUCTION! SL WABER "PowerMaster" Surge/Noise Suppressor

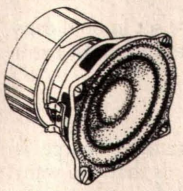
Protect your computer, phone, VCR, TV and stereo equipment from damaging transient voltage surges. Just plug in, and you've got full 3-line protection. Visual indicator lets you know that the device is functioning.
UL, CSA listed.
CAT # PW-103 $2.75 each
Formerly $3.75

S-VHS Tape (Used)

Super VHS tape users! Save a bundle on name-brand S-VHS, T-120 tapes. These tapes were used for a brief period, then bulk erased. The record-protect tabs have been broken out, so you will have to cover the notch with a piece of tape, but they work great and cost a fraction of the "new" price. Try some, you'll be back for more.
CAT #S-VHS $3.00 each
10 for $28.00 • 100 for $250.00

Shielded Woofer

Designed for use in Infinity center channel video sound systems. These well constructed woofers have shielded magnets to prevent interference with picture quality.



5 1/4" 6 OHM
1" voice coil. 8 oz. magnet. 50 watts max power. 3.125" deep.
CAT # SK-7346
$10.00 each
12 for $96.00

Miniature Temperature Sensor (THERMISTOR)

Keystone (Similar to #RL0503-17-56K-96-MS) 30K ohms @ 25 degree C. (77 degree F.) Negative temperature coefficient. 0.2" long X 0.09" diameter, epoxy insulated bead. 1.13" long teflon insulated AWG#30 wire leads. Prepped with 0.75" long metal tabs.
CAT# THR-19
2 for $1.50
box of 264 $150.48 (57¢ each)

3 Volt Lithium Coin Cell

Panasonic # BR2330-1GU
3 volt, 255 mAh coin cell. Lithium batteries have a very long shelf life and are great for memory back-up protection. 0.9" diameter x 0.12" thick. 0.7" between positive and negative pc leads.
CAT #LBAT-16
2 for $1.50
20 for $12.00 100 for $45.00 1K for $300.00

Ferrite Bead

TDK # HF70RH 16X28X9
1.1" x 0.63" od x 0.35" id.
CAT # FB-24 $1.00 each
10 for $8.50 - 100 for $70.00

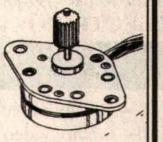
RED Ultrabright LED

PAINFULLY BRIGHT RED LED
2500 to 4000 mcd @ 20 ma. These T 1 3/4 (5 mm diameter) red LEDs are significantly brighter than conventional LEDs. At close range, they are painful to look at. They are great for attention getting displays that can be seen from a distance. Water clear in off-state.
CAT # LED-42
2 for $1.20
10 for $5.00 100 for $45.00 1000 for $400.00

High Brightness FLASHER LEDs

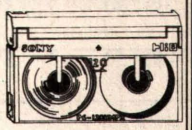
T 1 3/4 (5mm) high brightness RED LEDs with built-in flasher unit. 3-5 Vdc operation
CAT # LED-4 2 for 90¢
100 for $40.00 - 1000 for $300.00

Stepper Motor



Airpax # LB82246
Unipolar, two-phase, 6 lead stepper motor. 500 ohm coil. 7.5 degrees per step. 1.4" dia. X 0.7" body. Oval mounting flange has holes on 1.65" ctrs. 0.08" (2mm) dia. shaft is 0.4" long and is fitted with a 0.31" dia. gear with 18 teeth. 15" leads.
CAT # SMT-28 $2.00 each

"HI-8" Video Cassette



SONY Hi-8 Top quality, metal particle 120 minute video cassettes. *Used for a short time, then bulk-erased.* Each cassette has its own plastic storage box.
CAT # VCU-8
$3.00 each
10 for $28.00 100 for $250.00

ORDER TOLL FREE 1-800-826-5432

Cards VISA MasterCard DISCOVER

MAIL ORDERS TO:
ALL ELECTRONICS CORP.
P.O. BOX 567
VAN NUYS, CA 91408-0567

FAX (818) 781-2653 • INFO (818) 904-0524
INTERNET http://www.allcorp.com/
E-MAIL allcorp@allcorp.com

NO MINIMUM ORDER • All Orders Can Be Charged to Visa, Mastercard, American Express or Discover • Checks and Money Orders Accepted by Mail • Orders Delivered in the State of California must include California State Sales Tax • NO C.O.D • Shipping and Handling $5.00 for the 48 Continental United States - ALL OTHERS including Alaska, Hawaii, P.R. and Canada Must Pay Full Shipping • Quantities Limited • Prices Subject to change without notice.

MANUFACTURERS - We Purchase EXCESS INVENTORIES... Call, Write, E-MAIL or Fax YOUR LIST.

CIRCLE 214 ON FREE INFORMATION CARD

Use ELECTRONICS NOW Classifieds

READ BY ELECTRONIC BUYERS AND SELLERS AND TRADERS

INSTRUCTIONS FOR PLACING YOUR AD!

HOW TO WRITE YOUR AD

TYPE or PRINT your classified ad copy CLEARLY (not in all capitals) using the form below. If you wish to place more than one ad, use a separate sheet for each additional one (a photo copy of this form will work as well). Place a category number in the space at the top of the order form (special categories are available). If you do not specify a category, we will place your ad under miscellaneous or whatever section we deem most appropriate.

We cannot bill for classified ads. **PAYMENT IN FULL MUST ACCOMPANY YOUR ORDER.** We do permit repeat ads or multiple ads in the same issue, but in all cases, full payment must accompany your order.

WHAT WE DO

The first word and company name of each ad are set in bold caps at no extra charge. No special positioning, centering, dots, extra space, etc. can be accommodated.

RATES

Our classified ad rate is $2.50 per word. Minimum charge is $37.50 per ad per insertion (15 words). Any words that you want set in bold are each .40 extra. Indicate bold words by underlining. Words normally written in all caps and accepted abbreviations are not charged anything additional. State abbreviations must be post office 2-letter abbreviations. A phone number is one word.

If you use a Box number you must include your permanent address and phone number for our files. ADS SUBMITTED WITHOUT THIS INFORMATION WILL NOT BE ACCEPTED.

For firms or individuals offering Commercial products or Services. **Minimum 15 Words.** 5% discount for same ad in 6 issues within one year; 10% discount for same ad in 12 issues. **Boldface (not available as all caps),** add .40 per word additional. **Entire ad in boldface,** add 20%. **Tint screen behind entire ad,** add 25%. **Tint screen plus all boldface ad,** add 45%. **Expanded type ad,** add $4.00 per word.

General Information: A copy of your ad must be in our hands by the 13th of the fourth month preceding the date of issue (i.e. Sept issue copy must be received by May 13th). When normal closing date falls on Saturday, Sunday or Holiday, issue closes on preceding work day. Send for the classified brochure.

DEADLINES

Ads not received by our closing date will run in the next issue. For example, ads received by November 13 will appear in the March issue that is on sale January 17. ELECTRONICS NOW is published monthly. No cancellations permitted after the closing date. No copy changes can be made after we have typeset your ad. NO REFUNDS, advertising credit only. No phone orders.

CONTENT

All classified advertising in ELECTRONICS NOW is limited to electronics items only. All ads are subject to the publishers' approval. WE RESERVE THE RIGHT TO REJECT OR EDIT ALL ADS.

AD RATES: $2.50 per word. Minimum $37.50

Send you ad payments to:
ELECTRONICS NOW 500 Bi-County Blvd, Farmingdale, NY 11735-3931

CATEGORIES

100 -- Antique Electronics
130 -- Audio-Video Lasers
160 -- Business Opportunities
190 -- Cable TV
210 -- CB-Scanners
240 -- Components
270 -- Computer Equipment Wanted
300 -- Computer Hardware
330 -- Computer Software
360 -- Education
390 -- FAX
420 -- Ham Gear For Sale
450 -- Ham Gear Wanted
480 -- Miscellaneous Electronics For Sale
510 -- Miscellaneous Electronics Wanted
540 -- Music & Accessories
570 -- Plans-Kits-Schematics
600 -- Publications
630 -- Repairs-Services
660 -- Satellite Equipment
690 -- Security
710 -- Telephone
720 -- Test Equipment
730 -- Wanted

CLASSIFIED AD COPY ORDER FORM

Place this ad in Category #_____ **Special Category $30.00 Additional** _____

1 - $37.50	2 - $37.50	3 - $37.50	4 - $37.50	29 - $72.50	30 - $75.00	31 - $77.50	32 - $80.00
5 - $37.50	6 - $37.50	7 - $37.50	8 - $37.50	33 - $82.50	34 - $85.00	35 - $87.50	36 - $90.00
9 - $37.50	10 - $37.50	11 - $37.50	12 - $37.50	37 - $92.50	38 - $95.00	39 - $97.50	40- $100.00
13 - $37.50	14 - $37.50	15 - $37.50	16 - $40.00				
17 - $42.50	18 - $45.00	19 - $ 47.50	20 - $50.00				
21 - $52.50	22 - $55.00	23 - $57.50	24 - $60.00				
25 - $ 62.50	26 - $65.00	27 - $67.50	28 - $70.00				

Total words _____ $2.50 per word = $_____

Bold Face _____ $0.40 per word = $_____

Special Heading _____ $30.00 = $_____

Other _____ = $_____

Total classified ad payment $_____ **enclosed** **TOTAL COST OF AD $** _____

[ ] Check **[ ] Mastercard** **[ ] Visa** **[ ] Discover** Card # _____ Expiration Date __ __/__ __

Signature_____

Name _____ Phone _____

Address_____ City State Zip _____

MEMBRANE SWITCH KITS!

FLAT PANEL KEYPADS ASSEMBLE IN MINUTES WITH YOUR LEGEND

AVAILABLE IN 4, 12, 16, 24 & 40 KEY TYPES

CONNECTOR AND BEZEL INCLUDED!

OPTIONAL "CLICKDOMES" AVAILABLE

DSK-4 $9.89

DSK-12 $14.29

INDUSTRIAL TYPES AVAILABLE

MORE THAN 30 LAYOUTS TO FIT MOST APPLICATIONS

CALL FOR FREE BROCHURE

SIL-WALKER

880 CALLE PLANO, UNIT N
CAMARILLO, CA 93012

PHONE: (805) 389-8100

FAX: (805) 484-3311

VISA / MASTERCARD

WHOLESALE PRICES STARTING AS LOW AS $99.00

CABLE TV DESCRAMBLERS

CONVERTERS
FILTERS · VIDEO STABILIZERS

1 Year Warranty on All Products.
Affordable Extended Warranty.
FREE CATALOG!

30 Day FREE TRIAL

Call the Cable Professionals 24 Hours A Day!

Orion Electronics

1-800-379-3976

HTTP://WWW.ORION-ELECTRONICS.COM

FCC License Preparation

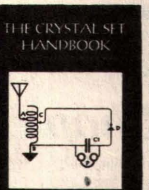
Avionics, Marine, Radar exam-prep
HOMESTUDY, fast, easy & inexpensive
Manuels, Audio, Video, Disks
*** GUARANTEE PASS***
FREE BROCHURE-1-800-800-7555
See on-wptpub@worldaccessnet.com
WPT PUBLICATIONS

SURVEILLANCE HIDDEN CAMERAS
DIRECT FROM MANUFACTURER–BEST PRICE IN THE MARKET

Ultra miniature hidden camera, in dome, smoke or motion detector. B/W or Color. Wide view angle. Low light sensitivity + super sharp images, plus video and audio output. From $159.00. Also 1/3" B/W board Cameras w/mic, only $99.00 USD. Wireless hidden camera, start at only $249.00 USD. Plus $5.95 for S/H. Whole/Retail Welcome. COD, Check, Money Order or Visa/MC.

BOLIDE INTERNATIONAL CORPORATION
PH: (800) 355-0895 or (818) 575-8178
9660 Flair Drive #318, El Monte, CA 91731
http://www.bolideamazingproducts.com

Get your copy of the
CRYSTAL SET HANDBOOK



Go back to antiquity and build the radios that your grandfather built. Build the "Quaker Oats" type rig, wind coils that work and make it look like the 1920's! Only **$10.95** plus **$4.00** for shipping and handling. **Claggk Inc., P.O. Box 4099, Farmingdale, NY 11735.** USA Funds ONLY! USA and Canada—no foreign orders. Allow 6-8 weeks for delivery. MA01

Cable TV Outlet

Factory Direct!

Get the Clearest Coverage of Sports, Movies, News, Main Events and Adult!

-Unbeatable Wholesale Pricing-
-Converters/Descramblers-
-Filters and Accessories-
-Premium Channel Coverage-
-Full Satisfaction Guaranteed-

QB VIDEO

Open M-F 9a to 5p (CT)

1-800-249-3025

Visa, MC & C.O.D.'s Welcome

There's a life to be saved right now.

Please give blood.

Call 1-800 GIVE LIFE

Ad Council

American Red Cross

CMM
Monitor Test Equipment

Checker 12e

Now you can repair and test Computer monitors with ease. With sweep rates up to 64Khz., eight step gray scale, white screen, single color mode. Mac II, EGA, CGA support, you can run almost ANY PC monitor. And it is EASY to use. Color front panel displays show just what you should see. Don't let its' small size fool you. It is the most powerful handheld available, and it supports ALL basic VGA modes (some don't). It is suitable for bench or field operations. Battery or AC operation.

PRICE:$295

Checker Jr.

Looking for a SMALL battery operated monitor test pattern generator that will fit in your pocket? The Checker Jr. is it. It displays a very useful 64 color pattern. You can evaluate size, focus, linearity, color tracking, and balance. It operates in the 640 × 480 mode (31.5Khz × 60Hz.), and is very easy to use. Use it anywhere.

PRICE: $99.95

Checker TV Pro & TV Jr.

The TV Pro is just the tool for your repair bench. It provides Video, S-Video, and RF outputs. It also has the most important pattern, GRAY SCALE! You can't set up a color TV without it. All with NTSC standards and COMPLEX sync. The RF output also includes an audio tone and STEREO signaling. With colorbars, gray scale, crosshatch with dots, you can set and test quickly.

Checker TV Pro..PRICE: $499.95

The TV Jr. is a small NTSC video generator with colorbars, crosshatch with dots, white, red, blue, green, and black screens. Small enough to fit in your pocket, powerful enough to drive the largest projection TV!

Checker TV Jr....PRICE: $129.00

Computer & Monitor Maintenance, Inc.

1-800-466-4411 • 770-662-5633

http://www.computermonitor.com

Interactive catalog:www.tekview.com

TV cable

CONVERTERS & EQUIPMENT

* 30 days money back guarantee
* 1 yr warranty
* Quantity Discounts
* Dealers Welcome!

VISA MC AMEX C.O.D.

TekView Electronics

(800)739-2253

EZ-EP DEVICE PROGRAMMER - $169.95

Check Web!! -- www.m2l.com

Fast - Programs 27C010 in 23 seconds

Portable - Connects to PC Parallel Port

Versatile - Programs 2716-080 plus EE and Flash (28F,29C) to 32 pins

Inexpensive - Best for less than $200

- Correct implementation of manufacturer algorithms for fast, reliable programming.
- Easy to use menu based software has binary editor, read, verify, copy, etc. Free updates via bbs or web page.
- Full over current detection on all device power supplies protects against bad chips and reverse insertion.
- Broad support for additional devices using adapters listed below.

Available Adapters

EP-PIC (16C5x,61,62x,71,84)	$49.95
EP-PIC64 (62-5,72-4)	$39.95
EP-PIC12 (12C50x)	$39.95
EP-PIC17 (17C4x)	$49.95
EP-51 (8751,C51)	$39.95
EP-11E (68HC11 E/A)	$59.95
EP-11D (68HC711D3)	$39.95
EP-16 (16bit 40pin EPROMS)	$49.95
EP-Z8(Z86E02,3,4,6,7,8)	$39.95
EP-SEE2 (93x,24x,25x,85x)	$39.95
EP-750 (87C750,1,2)	$59.95
EP-PEEL (ICT22v10,18v8)	$59.95
EP-1051(89C1051,2051)	$39.95
EP-PLCC (PLCC EPROMs)	$49.95
EP-SOIC (SOIC EPROMs)	$49.95

Many Other Adapters Available

M²L Electronics

310/837-7818 Fax/BBS: 310/841-6050

3526 Jasmine #4; Los Angeles, CA 90034

CA orders add 8.25% sales tax.

http://www.m2l.com

COMPLETE INTEGRATED CAD/CAE SYSTEM

Schematic, Simulation and Layout

EDWIN NC * Delux 3

- Full integration of Schematic and Layout
- On-line help
- Library viewer with editing possibility
- Up to 100 schematics sheets
- Up to 32 layers
- Automatic DRC with user specified parameters
- Automatic component renaming
- Mixed-mode simulation (AC, DC and TD analysis)

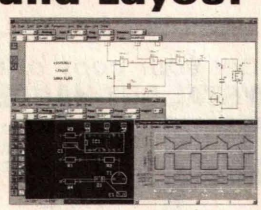
Optionals:

- Thermal Analysis for PCI: $ 29,99
- EDSpice Simulator (Spice): $ 59,99
- EDCoMx (Spice model generator): $29,99

FOR ONLY $149,99

Windows is registered trademark of Microsoft Inc.

MICROSOFT WINDOWS



EDAShop

P.O. Box 55-8207

Miami, Florida 33255-8207

Phone: (305) 267-4005 Fax: (305) 267-0709

Web site: http://www.edashop.com

* The "NC" version (Non-Commercial) is destinated only for students, hobbiests and educational institutions. Companies must purchase the "Professional" version. However, there aren't any diferences between "NC" and "Professional" versions.

MONDO·TRONICS'

ROBOT STORE

* KITS * Your

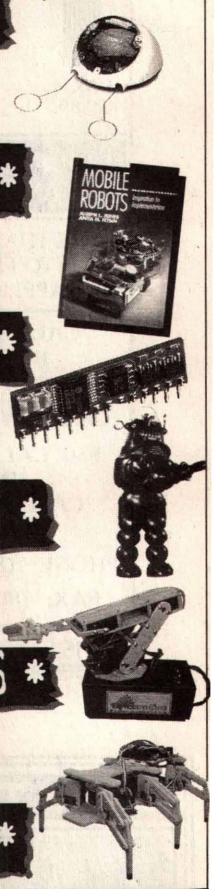
* BOOKS * Mailorder

* PARTS * Source

* VIDEOS * For

* MODELS * Robots!

* MORE! *



(REQUEST OUR FREE CATALOG)

www.robotstore.com

800-374-5764

Or write to us:

4286 Redwood Hwy #226-137

San Rafael CA 94903

Phone 415-491-4600 • Fax 415-491-4696

Email info@mondo.com

VIDEO SYNC GENERATOR

Restores Horizontal and Vertical Sync Lines from Distorted Video

Lost Sync

Restored Sync with VSG

For Free Information Package and Pricing

VISA Call 219-236-5776 MasterCard

www.south-bend.net/rcd

R.C. Distributing, PO Box 552, South Bend, IN 46624

Quality Microwave TV Systems

WIRELESS CABLE - ITFS - MMDS

ATV - INTERNATIONAL - S-BAND

Amplifiers • Antennas • Books • Components

Filters • Systems • Video Products

- RF Frequency 1990 - 2700 MHz
- Cable Ready - VHF - UHF Outputs
- SASE For "FREE" Catalog or Send $1

PHILLIPS-TECH ELECTRONICS

PO Box 8533 • Scottsdale, AZ 85252

CHALLENGER SYSTEM 33-Channel 52dB+ Gain Complete Grid $265 Five Year Warranty FREE SHIPPING

ORDER LINE 800-880-MMDS

CATALOG / INFO 602-947-7700

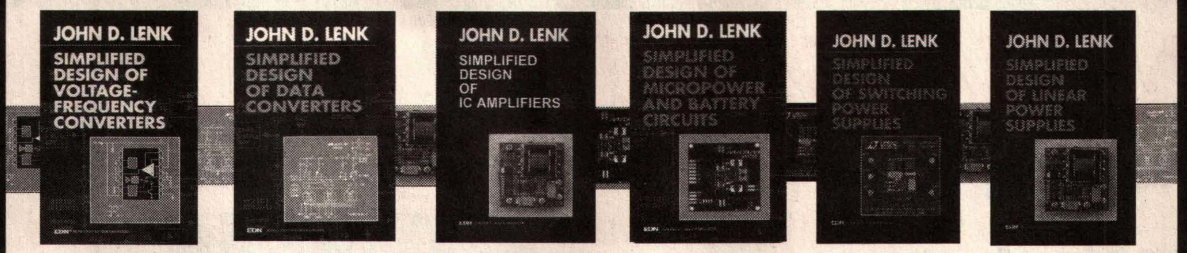
FAX LINE 602-947-7799

Visa • M/C • Amx • Disc • COD's • Qty Pricing

Key Titles from... Newnes

An imprint of Butterworth-Heinemann

Buy more than 1 book and take 15% off total order


JOHN D. LENK
SIMPLIFIED DESIGN OF VOLTAGE-FREQUENCY CONVERTERS
JOHN D. LENK
SIMPLIFIED DESIGN OF DATA CONVERTERS
JOHN D. LENK
SIMPLIFIED DESIGN OF IC AMPLIFIERS
JOHN D. LENK
SIMPLIFIED DESIGN OF MICROPOWER AND BATTERY CIRCUITS
JOHN D. LENK
SIMPLIFIED DESIGN OF SWITCHING POWER SUPPLIES
JOHN D. LENK
SIMPLIFIED DESIGN OF LINEAR POWER SUPPLIES

Lenk Series

Simplified Design of Switching Power Supplies
by John D. Lenk
1996 • 225pp • pa •
0-7506-9821-7 • $29.95

Simplified Design of IC Amplifiers
by John D. Lenk
1996• 240pp • pa •
0-7506-9508-0 • $29.95

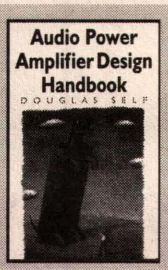
Simplified Design of Voltage-Frequency Converters NEW
by John D. Lenk
September 1997 • 304pp •
pa • 0-7506-9654-0 • $29.95

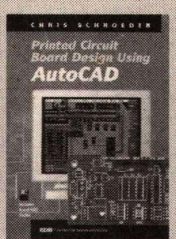
Simplified Design of Data Converters NEW
by John D. Lenk
April 1997 • 242pp • pa •
0-7506-9509-9 • $29.95

Simplified Design of Linear Power Supplies
by John D. Lenk
1996 • 246pp • pa •
0-7506-9820-9 • $29.95

Simplified Design of Micropower and Battery Circuits
by John D. Lenk
1996 • 240pp • pa •
0-7506-9510-2 • $29.95

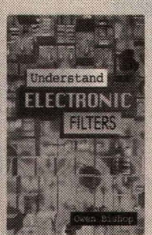
More Books from Newnes

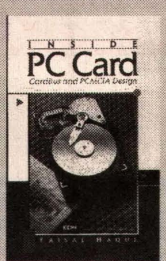




PCB Design Using AutoCAD
by Chris Schroeder
Aug 1997 • 336pp
• pa • 0-7506-9834-9
• $44.95

Understand Electronic Filters
by Owen Bishop
1996 • 180pp • ha •
0-7506-2628-3 •
$26.95





Inside PC Card
by Faisal Haque
1996 • 352pp • ha •
0-7506-9747-4 •
$52.95

Audio Power Amplifier Design Handbook
by Douglas Self
1996 • 256pp • pa •
0-7506-2788-3 •
$34.95

High Performance Audio Power Amplifiers
by Ben Duncan
1996 • 288pp • ha •
0-7506-2629-1 •
$59.95

Digital Storage Oscilloscopes
by Ian Hickman
1996 • 208pp • pa •
0-7506-2856-1 •
$39.95

Please send me the book(s) listed below. (Buy more than one, and take 15% off the total order.)

Write book number(s) here:

Mail your order to: Butterworth-Heinemann, Fulfillment Center, 225 Wildwood Ave., Woburn, MA 01801 USA

Name _____

Address _____

City _____ State _____ Zip _____

Phone _____ Fax _____

E-mail _____

☐ **Please send me a free Newnes catalog, Item #645.**

Phone: 1-800-366-BOOK **Fax: 1-800-446-6520**

E-mail your order to orders@repp.com

☐ I have enclosed a check for $ _____

☐ Please charge my:

☐ Visa ☐ MasterCard ☐ American Express

Card no. _____ Exp. date _____

Signature _____

U.S. Customers: Please add $4.00 handling fee for the first item ordered, $1.50 for each additional item, to all check and credit card orders. Billed orders will be charged additional shipping based on weight and destination. All U.S. orders must include your state sales tax. Prepayment or company purchase order is required for all orders. Prices subject to change without notice.

Canadian Customers: Please pay by credit card or in U.S. funds and include 7% GST on books and handling.

European Customers: Add £2.00 UK and surface postage. ☐ Check for Air Mail; extra cost will be charged.

A member of the Reed Elsevier plc group

TS232

Visit our web site: http://www.bh.com/newnes

CIRCLE 310 ON FREE INFORMATION CARD

The Only 100% Legal, FCC approved, DESCRAMBLER you can buy!

NAVIGATOR II...

The only legal way to own your converter!

- 250 Channel Capacity
- Subscribe to two different cable systems simultaneously
- Interactive On-Screen Display
- Watch one premium channel while recording another
- Electronic program guide shows all programming over next 7 days
- One Touch Recording

NO RENTAL FEES! Advanced Features!

Most advanced set-top you can buy!

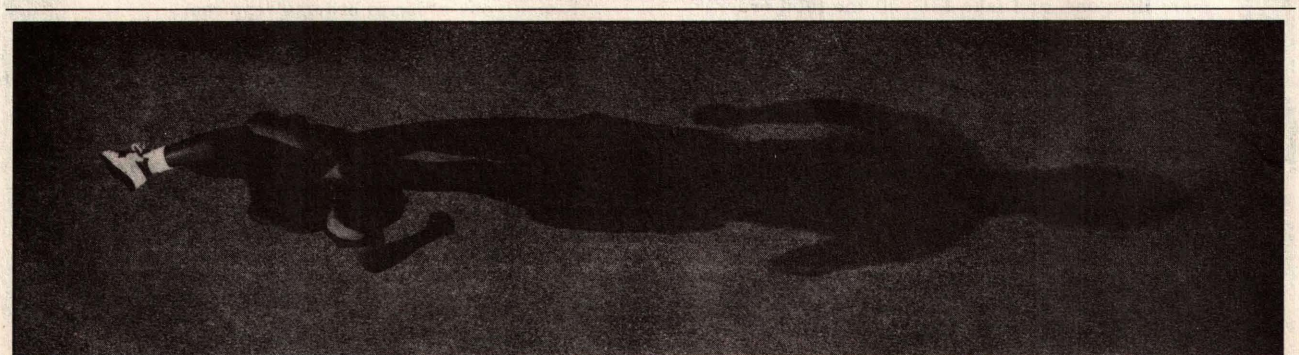
FCC & UL Approved

Save Money!

DYNAMIC Technologies • Phone: 1-800-643-4258

Suite 541064 • Boystown, NE 68154

CIRCLE 312 ON FREE INFORMATION CARD



SEE WHAT TAKES SHAPE. EXERCISE.

American Heart Association

© 1992, American Heart Association

AMAZING PRODUCTS!

ELECTRONIC & SCIENTIFIC DEVICES

LASER WINDOW BOUNCE SCIENCE PROJECTS

ALL NEW!

USES SCATTERED AND DIRECT REFLECTIONS

Remarkable concept allows user to hear sounds within a premise over a beam of laser light reflected from a window or similar surface. Experimental device provide hours of interesting and educational use. Utilizes a visible red laser that simplifies alignment and discourages illegal use. Usable range will vary-expect about 20 to 50 meters. Optional lens will increase range 200 to 400 meters! Further range requires expensive optics. Requires a sturdy video tripod (not incl.) Caution-check local law in your state if planning to use for accessing oral communication. REQUIRES OPTICAL ALIGNMENT

LWB5 Plans.....***$20.00*** ***LWB5K*** KIT/PLANS.....***$149.50***

LWB50 Ready to Use With Selected Laser Pointer.....***$249.50***

LWB70 Above With High Performance Laser Gun Sight, Long Range Extender Lens and Cushioned Headsets.....***$299.50***

WIRELESS LAB KITS

ALL PARTS TO BUILD 6 EXCITING TRANSMITTER PROJECTS

1. *Super Sensitive Ultra Clear 1Mile+ Voice Transmitter*
2. *1 Mile + Telephone Transmitter*
3. *Line Powered Telephone Transmitter Never Needs Batteries!!*
4. *Tracking/Homing Beacon "Beeping Transmitter"*
5. *Transmitter Rebroadcasts Video or Audio Outputs*
6. *Short Range TV/FM Disrupter NEAT PRANK!!! Discretion Advised*

All 6 Above Kits Plus FREE Info Data Pack on "HELPFUL HINTS" Building and Tuning" Wireless Devices

COMBOX Parts and Plans for above!..$59.50
COMBOP Plans for all the above!.....$10.00

ULTRA BRIGHT LASERS

4 to 7x brighter 650-630 nm Radiation

ALL METAL CONSTRUCTION
1 YEAR WARRANTEE
BATTERIES INCLUDED

LAPN65 15mw equiv 2000 ft.....***$29.95***

FOCUSABLE LASER POINTERS

From a Small Dot to a Large Spot!

LAPN65F Focusable Above *LAPN65*..***$39.95***
LAPN63F Focusable/4000' Range.....***$69.95***

FANTASTIC VISUAL EFFECTS

Complex Output Devices Projects Visible Lines, Dashed Lines, and Geometric Shapes and Patterns. Great Construction Aids or Special Lighting Effects. Produce a Small Light Show.

LASER PATTERN GENERATOR

5 Complex Light Designs
Fits on Your Key Chain
Includes 3 LR44 Batteries

LAPN65PT 15 mw equiv@670nm...***$29.95***

TRANSISTORIZED TESLA COIL

TURNS A LIGHT BULB INTO A SPECTACULAR PLASMA DISPLAY

Transmits Wireless Energy
Noiseless Operation
Pyrotechnic Effect
12 VDC/5 Amps or Battery
115 VAC Optional Converter
Adjustable Frequency Control For Effect

TCL5 Plans.....***$8.00***
TCL5K Kit/Plans.....***$59.50***
TCL50 Ready to Use.....***$109.50***
12DC/7 12VDC@7Amps.....***$39.50***

HOVERBOARD PLANS

Kit Soon to be Available

28 Pages of "how to" build a magnetic force field capable of containing a column of ionized air up to several psi! Proven theory may require additional experiment

HOVER Plans.....***$25.00***

3 MI FM BROADCAST TELEPHONE TRANSMITTER

Tunable On FM Broadcast. Excellent Telephone Project. Only Transmits When Phone is Used

VWPM7K Kit/Plans ***$39.50***
BEEP1K Beeper Alert Kit..$19.95

HIGH POWER STUNGUNS

STUN100 100KV StunGun...***$29.50***
STUN200 200KV StunGun...***$49.50***
STUN300 300KV StunGun...***$69.50***

JACOBS LADDER

Observe a pyrotechnical display of "traveling" fiery plasma. Starts off as 1/2" arc and expands to over 3" before evaporating into space. This is an excellent attention getting display as well as a winning science project!! With arc control.

JACK1 Plans.....***$8.00***
JACK1K Kit Minus Case.....***$129.50***
JACK10 Ready to Use ***$249.50***

12KVGEN20 Pwr Supply Only.....***$99.50***
12KVGEN2K Kit of Pwr Supply.....***$79.50***

250KV TESLA COIL

10-14" of Explosive Bolts of Lightning

Transmit Wireless Energy
Strange and Bizarre pyrotechnical effects.
Ion Motors Anti-Gravity
Size 20" H x 8" Sq
Weight - 25 Pounds
115 Volts/2 Amps AC
Labeled "Use Caution"

BTC3 Plans.....***$15.00***
BTC3K Kit/Plans.....***$399.50***
BTC30 Ready to Use.....***$499.50***
BTC4 Plans 500Kv 24 to 30".....***$20.00***

HIGH CRIME AREA SECURITY!

INFINITY+ TRANSMITTER

ROOM MONITOR/ LINE GRABBER/CONTROLLER

- *MONITOR YOUR PREMISES* Avoid ambushes and break ins.
- *ACCESS ON GOING CALLS* Longwinded teenagers!!
- *CONTROL 8 APPLIANCES* Remote control your home!!!
- *EXTRA ADDED FEATURE!!!* Redirect those"COIN HUNGARY" Toll Calls Made From Pay Phones!!

TELCON3 Plans ***$10.00***
TELCON3K Kit/Plans.....***$99.50***
TELCON30 Ready to Use.....***$199.50***

Programmed With built in BEEPER ALERT

PHASOR BLAST WAVE PISTOL

130 db of Directional Sonic Shock Waves Energy
Handheld and Battery Operated

PPP1 Plans.....***$8.00***
PPP1K Kit/Plans.....***$49.50***
PPP10 Ready to Use.....***$79.50***

ATTENTION! HIGH VOLTAGE EXPERIMENTERS

Battery Powered Mini Sized Modules for research in: HOVERCRAFT, ION GUNS FORCE FIELDS, SHOCKERS etc

MINIMAX4 4KV@10ma.....***$19.50***

BURNING LASER RAY GUN

BLASTS THRU THE HARDEST OF METALS!

All Parts Available

A FUTURISTIC CONCEPT!!

LAGUN2 Plans.....***$20.00***

BURNING CO2 BENCH LASER

HOTTER THAN MOST TORCHES!

All Parts Available

LC7 Plans.....***$20.00***

KINETIC ELECTRIC GUN

PIONEER A FUTURISTIC WEAPON!

DANGER HIGH VOLTAGE

500 Joules Energy Storage
Constant Current Charging
Triggered Spark Switch
Ballistic Velocities
Handheld Battery Operated
Labeled A Dangers product

PROTOTYPED IN OUR LABS JOIN THE RESEARCH!

EGUN1 Plans with Parts List.....***$20.00***
All Parts are Individually Available

3Mi FM BC TRANSMITTER

Safety Product Allows Listening to Children or Invalids in Hazardous Areas, Pools, Ponds etc. Great Security Intrusion Alert! Uses FM Table Top Radio.

FMV1K Kit/Plans.....***$39.50***

ION RAY GUN *PROJECTS ENERGY!*

Star Wars Technology Demonstrates Weapons Potential!

IOG7K Kit/Plans.....***$99.50***

GRAVITY GENERATOR

Demonstrates a unique phenomena of electrical reactions that produce the effect of "anti-gravity". You build and levitate a small mock space ship from simple materials. Excellent scientific demonstration of a fascinating method of levitation. ***Levitate an Object!***

GRA1 Plans and Book.....***$20.00***
GRA1K Pwr Sup Kit/Plans...***$99.50***
GRA10 Assbled Pwr Sup...***$149.50***

ELECTRONIC HYPNOSIS AND MIND CONTROL

Generates Highly Effective Audible and Visual Stimuli With Bio-Feedback That Can Induce Hypnotic as Well as ALPHA Relaxed States of the Mind. Place Subjects " Under" Your Control. Enhances Hidden PSYCHIC Ability in Many People!

MIND Plans.....***$15.00***
MIND2K Kit and Plans.....***$49.50***
MIND20 Assembled.....***$89.50***

TELEPHONE TAPING SYSTEM

EXTENDED X4 PLAY

Tapes Phone Conversation 20 Megs Input 2! Check Laws!

TAP30X Ready to Use.....***$84.50***
BEEP10 Beeper Alert.....***$29.95***

SHOCK FORCE FIELD/ VEHICLE OBJECT ELECTRIFIER

Hand Shock Bails, Wands. Electrify Objects. Great Payback for Those Wiseguys!

CAUTION Manitrapping Is Illegal!!

SHK1K Kit of Pwr Module....***$19.50***

ATTENTION!! RAILGUN EXPERIMENTERS

HIGH ENERGY PULSER

EXPERIMENTORS AND RESEARCHERS

RAIL GUN, COIL GUN, EXPLODING WATER, ANTIGRAVITY, MASS WARPING ,LEVITATION, PLASMA PROPULSION, LATTICE SNAPPING, EMP etc

- Lossless Energy Charging
- Programmable Voltage to 2 KV and Energy Control to 3 KJ
- Triggered Spark Switch [1KJ]
- Universal 12 VDC or 115 VAC
- 7.5 X 7.5 X 7" Light weight

UNIT IS SHOWN WITH OUR "DISTRIBUTED ENERGY SOURCE" LAB RAIL GUN

HOTSHOT

HEP3 Plans High Energy Pulser/Ignitor.....***$15.00***
HEP3K Kit/Plans (Minus Energy Storage).....***$199.50***
HEP30 Assembled (Minus Energy Storage).....***$299.50***
HEPCAP 800 Joules Energy Storage.....***$199.50***

INFORMATION UNLIMITED DEPT EN 1098
BOX 716 AMHERST, N.H. 03031

24 Hr Toll FREE "Orders Only" Line 1-800-221-1705
Fax Your Order to 1-603-672-5406
9 to 5 pm EST Information Line 1-603-673-4730
See Our Web Site at http://www.amazing1.com

We Accept MC, VISA, Cash, MO, Checks. Please add $5.00 Shipping. COD Orders Add Additional $4.75.
FREE CATALOG ON REQUEST!!

Find Bad Capacitors

In-Circuit

with the

Capacitor Wizard

ESR @100Hz
Capacitor WIZARD
In-Circuit Capacitor Analyzer
ON
OFF
Capacitor WIZARD
IN-CIRCUIT ESR METER
BEEP ADJUST
LOW BAT
OHMS ZERO
General Guidelines - Caps 1uf and up
Switching & Motor Caps - Good under 1/2 ohm
Others - Good under 3 ohms
If in doubt, compare with a known GOOD Cap
WARNING! Disconnect all power to device under test and DISCHARGE all capacitors before using this meter!
Independence ELECTRONICS INC.
Independence, Mo USA

The Capacitor Wizard is an extremely FAST and RELIABLE device designed to measure ESR (Equivalent Series Resistance) on capacitors of 1uf and larger "***IN CIRCUIT***", eliminating the need to remove the capacitor for accurate tests. The Capacitor Wizard finds BAD caps ***IN CIRCUIT*** that even VERY EXPENSIVE cap checkers MISS ENTIRELY, even out of the circuit!! Standard capacitor meters cannot detect any change in ESR therefore they miss bad capacitors leading to time consuming "Tough Dog" repairs. ***Technicians say it is the most cost effective instrument on their workbench.***

Made in the USA

Order Today

Only $179.95

Call 1-800-394-1984

http://www.heinc.com

Int. # 316-744-1993

Fax 316-744-1994

6222 N. Oliver, Kechi, KS 67067

30 day money back guarantee

HOWARD ELECTRONIC INSTRUMENTS INC

Your Desoldering Specialists

MasterCard

CLASSIFIED

MISCELLANEOUS ELECTRONICS FOR SALE

PIECE parts for Delco OEM radios. Low pricing. Factory Original. No subs. Call today, 1 (800) 433-9657.

CHEAP device programmers $59.95 & up. **XU-MICRO,** PO Box 14681 Houston, TX 77021. Add $5.00 S&H

PLANS-KITS-SCHEMATICS

BIO-Stimulator featured in PE June issue. Tone muscles, relieve aches and pains with electronic acupuncture. Updated kit with enclosure $40.00 plus $2.50 S&H. **RAH PROJECTS,** PO Box 15904, N.B., California 92659

ELECTRONIC PROJECT KITS. 49 McMichael St. Kingston, ON., K7M 1M8. $3.00 catalog. www.qkits.com. **QUALITY KITS.**

CABLE TV

NEW! Jerrold and Pioneer wireless test units $125.00 each, also 75DB notch filters $19.95 each, quantity pricing available. Please call **KEN ERNY ELECTRONICS,** 24 hour order and information hot line (516) 389-3536.

CABLE descramblers and converters 10 lot decoders $38.00 ea. 10 lot converters $57.00 ea. Visa and Mastercard accepted. (304) 337-8027.

CABLE TV Descramblers. One piece units. Pioneer, 6310's Scientific Atlanta 8580's Dpv 7's and others. Lowest prices. Money back guarantee. **Precision Electronics** Houston,TX. 1-888-691-4610

Free Cable Descrambler Plans. For Details Write: Sierra Publishing, 909 E. Yorba Linda Blvd., Suite H-181, Dept. ENQ, Placentia, CA 92870

Signal Eliminator can block severe TV interference or unwanted channels! Order by channel number - 0 thru 36 available. Only $30.00 each plus $4.00 S/H. Quantity discounts. Money back guarantee. Prepay, Visa or Mastercard. COD $5.00 additional. Visit us on the web today at http://startcircuits.com/tvfilter. **Star Circuits,** PO Box 94917, Las Vegas, NV 89193. 1-800-433-6319.

CABLE TV major brands including ZENITH ST. 1600 $249.00 New Zenith add-on $99.00 Jerrold Model CFT 2014 $299.00 add-on TVT $70.00 WHOLESALERS WELCOME **1-800-822-8530**

Descramble cable with simple circuit added to Radio Shack RF Modulator and using VCR tuner instructions $10.00 TELECOM, Box 832-E1, Brushly, LA 70719

CABLE DESCRAMBLERS and converters, shop no more, best prices and tech support. **Extreme Electronics** 1-888-609-4910

NEW! Cellphone E.S.N. readers **$250** each, cell phone programmers **$175** each, cell phones **$25** each, DSS satellite dish card readers and programmers **$125** each, credit card readers **$250** each, Cable T.V. notch filters **50 cents** each, convertor boxes **$50** each, magnetic strip card readers for ATM machines, bank cards, drivers license, and all types of data acquisitions all under **$200** each. You pay these super low prices when you deal directly with the manufacturers. When you order "Direct Connection" a 150 page directory published by Ed Treki Publications, you will receive the largest collection of names, addresses, and phone numbers of all the leading American and International manufacturers of these products never before available. Stop paying second, third and fourth hand prices and deal directly with the source!!! Order your copy of "Direct Connection" today for **only $99.95 plus $5 shipping. All orders are sent C.O.D. Please call Ed Treki Publications 24 hour order hot line 914-544-2829.**

CABLE BOXES - ALL MODELS - ALL CHANNELS Jerrold Impulse DP, DPV & DPBB's, Pioneer or Scientific Atlanta-Lowest Prices in U.S. - $175.00 including remote, batteries and cable. Call for 10 lot pricing. Toll Free (888) 689-0779

BIG SALE!! NOTCH FILTERS $18.00. EXTERNAL ACTIVATORS and **DESCRAMBLERS FROM $99.00.** Test chips from $5.00. **BULLET/LD $10.00. NAME BRAND CABLE DESCRAMBERS FROM $135.00. LET US BEAT YOUR BEST PRICE. 1-800-449-9189 ANYTIME. SE HABLE ESPANOLE**

CABLE "Bullet Terminator and I.D. Blocker." Electronically shields yourself and your box. Free Hackers Guide included. **Lifetime guarantee. Wholesale prices. 1-800-820-9024.**

CABLE Descrambler!! Anyone can build in **seven steps** with **Radio Shack** parts. **Plans/Kit** from **$5.00 plus Free Bonus!! 1-800-818-9103.**

CABLE TV EQUIPMENT & ACCESSORIES. Wholesalers Welcome! 30 Day Moneyback Guarantee! Free Catalog! **PROFORMANCE ELECTRONICS, INC. 1-800-815-1512**

Cable descramblers including **New T-2 Testers.** Fully activates Jerrold DP-5-CFT22xx's. **Multimode, Fiber optics.** Descrambles everything permanently, guaranteed. Lowest single or lot prices available. Se habla en espanol. Call **Cableking** (203) 849-1759, 24 hours a day. Website address www.ntplx.net/-cablkingabl.htm.

Cable test modules/cubes. Pioneers, S/A, Tocoms, Jerrolds, Quantity discounts. Call **DCR.** Tel: (718) 624-8334, Fax: (718) 246-9731. No NY calls.

CABLE DESCRAMBLING, New secret manual. Build your own Descramblers for Cable and Subscription TV. Instructions, schematics for SSAVI, Gated Sync, Sinewave, $12.95, $2 postage. **CABLETRONICS,** Box 30502R, Bethesda, MD 20824.

CABLE TV DESCRAMBLERS. ALL MAJOR BRANDS HAVE MAKE AND MODEL NUMBER OF CONVERTER USED IN YOUR AREA WHEN CALLING. QUANTITY DISCOUNTS. K.D. VIDEO, 1-800-327-3407.

SATELLITE EQUIPMENT

SKYVISION! Your Satellite Home Entertainment Source. **Best values:** DBS and C/Ku-band equipment, including 4DTV. Most complete selection: Parts-Tools-Upgrades-Accessories! **Free** Discount Buyer's Guide. Call 800-543-3025. International 218-739-5231. www.skyvision.com.

FREE DSS TEST CARD information package. Works on new system and turns on all channels including PPV, adult and sport channels. Write **SIGNAL SOLUTIONS,** 2711 Buford Rd., Suite 180, Richmond VA 23235.

DSS Hacking: How to construct and program smart cards, w/pic 16C84, software. Complete DSS system schematics, $16.95. **CABLETRONICS,** Box 30502R, Bethesda, MD 20824.

VIDEOCYHER II descrambling manual. Schematics, video and audio. Explains DES, EPROM, CloneMaster, Pay-per-view $16.95, $2.00 postage. Schematics for Videocypher II Plus, $20.00. Schematics for Videocypher II 032, $15.00. Software to copy and alter EPROM codes, $25.00. VCII Plus EPROM, binary and source code, $30.00. **CABLETRONICS**, Box 30502R, Bethesda, MD 20824.

TEST EQUIPMENT

TEST Equipment pre-owned now at affordable prices. Signal generators from $50.00, oscilloscopes from $50.00. Other equipment including manuals available. Send $2.00 US for catalog. **Refunded** on first order. **J.B. Electronics,** 3446 Dempster, Skokie, IL 60076. (847) 982-1973.

TEST EQUIPMENT SALE! VIEW COMPLETE LIST AT WEB SITE "a-mall.com" or call **NOW** to recieve list by fax or mail. **AST GLOBAL ELECTRONICS:** Voice 888-216-7159; Fax: 814-398-1176; e-mail:astmrktg@wrench.toolcity.net

BUSINESS OPPORTUNITIES

ELECTRONICS BUSINESSES, Home based. Part/Full time. 250pg Comprehensive Guidebook, insider information. $19.95 24hr recording **(800) 326-4560** x 159

EASY WORK! EXCELLENT PAY! Assemble Products At Home. Call Toll Free 1-800-467-5566 EXT. 5192

EDUCATION & INSTRUCTION

LEARN Electronics. Home study. Outstanding careers. Free literature. **P.C.D.I.,** Atlanta, Georgia. 1 (800) 362-7070 Dept. ELF342.

CB-SCANNERS

CB Radio Modifications! Frequencies, kits, high-performance accessories, books, plans, repairs, amps, 10-Meter conversions. The best since 1976! Catalog $3.00. **CBCI,** Box 31500EN, Phoenix, AZ 85046.

COMPONENTS

SAVE $$$ Reclaimed electro-mech/electronic components and assemblies. SASE for list. 800/334-1159, **PMA Services,** 22347 La Palma Ave. #106, Yorba Linda, CA 92887

MISC. ELECTRONICS WANTED

TUBES: "oldest". "latest". Parts and schematics. SASE for lists. **Steinmetz Electronics,** 7519 Maplewood Ave., Hammond, Indiana 46324.

WANTED

WANTED: USED TEST EQUIPMENT. TURN IDLE OR UNWANTED EQUIPMENT INTO CASH. AST GLOBAL ELCTRONICS: Voice 888-216-7159; Fax: 814-398-1176; e-mail:astmrktg@wrench.toolcity.net

SCRAMBLING NEWS

Best satellite TV news includes coverage of piracy. Voice/Fax 716-283-6910. www.scramblingnews.com.

BEST BY MAIL

Rates: Write National, Box 5, Sarasota, FL 34230

IGH SCHOOL DIPLOMA Fast, Accredited, Member Christian Schools International. 1-800-470-4723.

CASH NOW FOR FUTURE PAYMENTS! We buy payments rom Insurance Settlements, Annuities, and Class Action wards. We also buy Owner Financed Mortgage Notes. Call &P Capital at 1-800-338-5815, Ext. 500.

OP $$$$s FOR TD's, Contracts, Mortgage Notes: 1-888-544-089.

LIMINATE HOUSEHOLD PESTS using the Ultrasonic estrepeller. Money-back guarantee. 1-888-430-7576 Ext. 120.

Take Stock in America U.S. SAVINGS BONDS

A public service of this magazine

PC - Based Test Instruments For Automatic Testing at Bench-Top Prices

- Instrument-on-a-card to plug into PC slot, and turn PC into a test station for automatic testing.
- An operation program included with instrument card, no need for extra software.
- No IEEE488 or RS232 hassle.

100 MHz Dual Universal Counter	$399
6 MHz Function/Sweep Generator	$549
60 MHz Digital Storage Scope	$749
100 MHz Digital Storage Scope	$999

For spec and to download demo : www.tcinst.com

TC INSTRUMENTS INC.®

29 Chaparral Dr., Pomona, CA 91766, USA • Tel: (909) 622-2006 • Fax: (909) 622-7778

ATTENTION DEALERS: WHOLESALE ONLY!

JAMES' ELECTRONIC SERVICES, LTD.
Formerly JES, Inc.

BEST PRICES!
FAST SERVICE
SAME DAY SHIPPING

EXCLUSIVE:

NEW!
Wavemaster 99 Channel
• Sleep Timer • Std./HRC Switch • Parental Control

10+	20 +	50+
$57	52	45

	5+	10+	20+
Panasonic 145	$72	65	60
Refurb. Panasonic 145	57	55	52
Panasonic 100	52	49	--
Panasonic 175	--- CALL! ---		
Starcomm DQN (99 ch; Refurb.)	49	45	39

TOLL FREE: 800-322-9690

VISA MasterCard

FAX: 516-246-5634

ADVERTISING INDEX

Electronics Now does not assume any responsibility for errors that may appear in the index below.

Free Information Number		Page
—	Abacom Technology	84
—	ABC Electronics	96
—	Adeplex, Inc.	7
—	Aegis Research, Canada	74
—	AES	93
213	Alfa Electronics	73
214	All Electronics	101
—	Allison Technology	70
—	Amaze Electronics	74
282	American Eagle Publications	80
—	Andromeda Research	92
—	Arrow Technologies	96
313	Basic Electrical Supply	78
—	Bossman Electronics	70
309	Butterworth-Heinemann	105
322	C&S Sales, Inc.	76
320	Capital Electronics	82
332	Circuit Specialists	81
—	CLAGGK, Inc.	12
—	Cleveland Inst. of Electronics	19
—	Command Productions	72
—	Computer Monitor Maint.	103
226	Consumertronics	86
227	Cool Amp Conducto Lube	74
—	CRC Press	11
315	Dalbani Electronics	79
235	Danbar Sales.	87
—	Deco Industries	100
312	Dynamic Technology	106
—	EDASHOP	104
—	EDE - Spy Outlet	100
—	Electronic Tech. Today	9
—	Emac Inc.	80
—	Fair Radio	72
—	FerretTronics	94
335	Foley-Belsaw	89
328	Fotronic	80
334	Gateway Products	82
—	General Device Instruments	94
122	Global Specialties	33
—	Grantham Col. of Engineering	4
329	Graymark International	84
—	Home Automation	90
331	Howard Electronics	99
—	Howard Electronics	108
—	IEC	97
—	Information Unlimited	107
126	Interactive Image Technologies	CV4
—	Intronics, Inc.	94
319	IVEX Design	91
—	IVEX Design	92
—	James Electronics	109
330	Link Instruments	93
—	Lynxmotion	90
—	M²L Electronics	104
326	Mark V Electronics	69
327	MCM Electronics	75
251	Mendelson Electronics Surplus	96
—	Meredith Instruments	91
323	Merrimack Valley Systems	92
133	MicroCode Engineering	CV2
—	microEngineering Labs	100
—	Midwest Laser Products.	72
—	Mo-Tech Distributors	100
—	Modern Electronics	100
—	Mondo-tronics Inc.	104
325	Mouser Electronics	100
316	NCD Electronics	88
—	NRI Schools	35
—	NS International	100
—	Orion	103
262	Parts Express Inc.	83
—	PC Boards	88
—	Pioneer Hill Software	94
—	Point Six	90
—	Polaris Industries	65
324	Prairie Digital	84
264	Print (Pace)	85
—	QB Video	103
266	Ramsey Electronics	71
311	Roger's Systems Specialist	95
—	SE International	93
—	Sil Walker	103
270	Skyvision Inc.	67
—	Square 1 Electronics	97
321	Sun Equipment	CV3
—	Tab Books	3
—	TC Instruments	109
—	Tekview	104
318	Telulex	97
—	Test Equipment Sales	65
275	Timeline	66
—	U.S. Cyberlab	90
317	Visitect Inc.	78
—	Weeder Technologies	86
314	White Star Electronics	88
—	Wisch Communications	70

ADVERTISING SALES OFFICES

Gernsback Publications, Inc.
500 Bi-County Blvd.
Farmingdale, NY 11735-3931
1-(516) 293-3000
Fax 1-(516) 293-3115

Larry Steckler
publisher (ext. 201)
e-mail advertising@gernsback.com

Adria Coren
vice-president (ext. 208)

Ken Coren
vice-president (ext. 267)

Christina Estrada
assistant to the publisher (ext. 209)

Arline Fishman
advertising director (ext. 206)

Marie Falcon
advertising assistant (ext. 211)

Adria Coren
credit manager (ext. 208)

For Advertising ONLY

EAST/SOUTHEAST
Stanley Levitan
Eastern Advertising
1 Overlook Ave.
Great Neck, NY 11021-3750
1-516-487-9357
Fax 1-516-487-8402
slevitan26@aol.com

MIDWEST/Texas/Arkansas/Okla.
Ralph Bergen
Midwest Advertising
One Northfield Plaza, Suite 300
Northfield, IL 60093-1214
1-847-559-0555
Fax 1-847-559-0562
bergenrj@aol.com

PACIFIC COAST
Janice Woods
Pacific Advertising
Hutch Looney & Associates, Inc.
6310 San Vicente Blvd., Suite 360
Los Angeles, CA 90048-5426
1-213-931-3444 (ext. 228)
Fax 1-213-931-7309
woodyowl@aol.com

Electronic Shopper
Joe Shere
National Representative
P.O. Box 169
Idyllwild, CA 92549-0169
1-909-659-9743
Fax 1-909-659-2469
Jshere@gernsback.com

Megan Mitchell
National Representative
9072 Lawton Pine Avenue
Las Vegas, NV 89129
Phone/Fax 702-838-6924
Lorri88@aol.com

Customer Service
1-800-999-7139
7:00 AM - 6:00 PM M-F MST

SEC Sun Equipment Corporation

P. O. Box 97903, Raleigh, NC 27624 E-mail: sunequipco@ipass.net
To request FREE CATALOG, please call, fax, write, or e-mail us.

Quality Test Equipment for Cost-Minded People

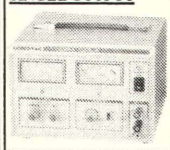
LODESTAR Lodestar Electronics Corp. Since 1979

One Year Warranty. 15 Day Money Back Guarantee. OEM WELCOME.
School purchase order accepted. Bids accepted. **VISA, Mastercard**
SALES REP./DISTRIBUTORS/OEM WANTED. **Discover, AmrExpr**
1-800-870-1955 / (919)870-1955 Fax:(919)870-5720

DC POWER SUPPLY (CC/CV)

All models: protection of short ckt, overload, reverse polarity, overvoltage; Constant Current & Voltage (CC/CV) are fully adjustable. Regulation: ≤.01%+3mV (line); ≤.01%+3mV (load); ≤1mV ripple.

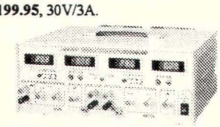
SINGLE OUTPUT *Analog Displays*



PS-303 $159.00, 30V/3A.
PS-305 $219.95, 30V/5A.
PS-1610S $289.00, 16V/10A.
PS-2243 $139.00, 12V/24V select, 3A.
PS-2245 $159.00, 12V/24V select, 5A.
8107 $399.95, 30V/10A.
8110 $289.95, 60V/3A.
8112 $399.95, 60V/5A.

Digital Voltmeter & Analog Ammeter
8200(8201) $179.95($239.95), 30V/3A(5A)
Digital Displays **8210/8300 $199.95**, 30V/3A.
8211/8301 $259.95, 30V/5A.

DUAL OUTPUTS
Independent/Tracking



Analog Displays
8108 $549.95, 60V/3A.
8109 $699.95, 60V/5A.
PS-303D $314.95, 30V/3A. **PS-305D $399.95**, 30V/5A.

TRIPLE OUTPUTS, a fixed 5V/3A output, Independ/Tracking
Digital Displays **8202(8203) $499.95($549.95)**, dual 30V/3A(5A).
Analog Displays **8102(8103) $399.95($489.95)**, dual 30V/3A(5A), with *Parallel* (30V/6A) and *Series* (60V/3A) Mode operation.

NTSC/PAL TV COLOR BAR GEN.

CPG-1366A $159.95, VHF NTSC; *Freq.*: 45.75, 175.25, 187.25 MHz; *RF Output*: 10mV. *Impedance*: 75 Ohm; *Video Output*: BNC, $1V_{p-p}$.
CPG-1367A $159.95, VHF PAL.

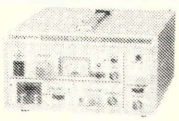
SWR/RF/mW POWER METER

310 $89.95, 1.8-150MHz; *RF Power*: 0-4W/20W/200W 3 ranges; *SWR Measurement.*:1.0~∞, 4W minimum. Accuracy: 5%-10%; *Insert Loss*: .3dB *Input/Output Imp.*: 50Ω; SO-239 plug
320 $89.95, 130-520MHz. Spec. 310.
330 $119.95, 1.8-520MHz. Spec. see 310.

SWR-3P $26.95 1.7-150MHz; *RF Power*: 0.5-10W, 0.5W-100W.
SWR-2P $22.95, 1.7-30MHz; *RF Power*: 0.5-10W.

mW RF Power Meter 340 $219.00, 1.8-500MHz; *RF Power*: 20mW/200mW/2W 3 ranges; *Imped.*: 50Ω; *Accuracy*: ±10% full scale; SWR <1.15; N-type connector; BNC type output..

FM STEREO MODULATOR



AG-2011A $549.00
RF SECTION:
Carrier: 98MHz ±2MHz;
Output: 10mV, 1mV & 0.1mV
COMPOSITE SIGNALS:
Pilot: 19KHz ±2Hz, 0.8Vrms
INT. MODULATION: 400KHz, 1KHz ±1%, 1Vrms, distortion < .5%;*L-R Separation:* >50dB.
EXT. MODULATION: *Freq.*: 50Hz-15KHz
L-R Separation: >45dB 100Hz-3KHz; >35dB 50Hz-15KHz.

TOOLKITS - ELECTRONIC/PC

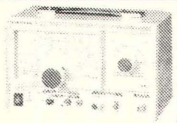
9ZA5 $29.99 U.S. Patented, 45-pcs. Contents: IC inserter/extractor with securers & bows, 3-prong part retriever, #0 phillips screwdriver, 1/8" flat srewdriver, self-hold tweezers, metal tweezers, extra parts tube, soldering iron, solder, crimping tool, long-nose plier, cutting plier, zipper vinyl case. Bits include: *Phillips*: #0/#1/#2/#3; *Flat*: 1/8"/3/16"/1/4"/9/32"; PZ1/PZ2; T8/T9/T10/T15/T20/T25/T27/T30/T40/T45; *Hex*: 5/64"/3/32"/1/8"/5/32"/3/16"; *Sockets*: 3/16" (5mm)/7/32" (5.5mm)/1/4" (6mm)/9/32" (7mm)/5/16" (8mm).
8G23 $34.99 23-pcs *Contents*: IC inserter/extractor with securer & bows, 3-prong part retriever, 3/16"/1/4" nutdriver, 3/16"/ 1/8" slotted screwdriver, #0/#1 phillips, reversible T10/T15 bits, re-versible #2 phillips/¼" slotted bits, tweezer, long-nose plier, cutter, 6" adj. wrench, soldering iron, solder, crimping tool, zipper case, manual.
Different packages available, call/write/e-mail/fax for detail.

STEREO/ALIGNMENT/SWEEMAR SCOPE

STEREO SCOPE **OS-7505B $369.00**, 0-10MHz/20mV.
ALIGNMENT SCOPE OS-7001A $369.00, 0-200KHz/1mV.

SWEEMAR SM-6225B/C $1999.95
Freq Range: (AM)490KHz; (FM)10-11.4MHz, *Accuracy*: ± 0.1%; *Marker*: (AM)455KHz, ±5KHz, ±10KHz; (FM)10.7MHz, ±7.5KHz, ±150KHz.

RF SIGNAL GENERATOR

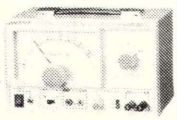


SG-4160B $124.95, 100KHz-150MHz up to 450MHz on 3rd harmonics in 6 ranges; AM modulation; *Accucy*: ±5%. *RF Output*: 100mVrms to 35 MHz; *Modulation*: Int. 1KHz (AM) =30%; Ext. 50Hz-20KHz, at least $1V_{rms}$ input. *Audio Output*: 1KHz, $2V_{rms}$ minimum.
SG-4162AD (with Freq. Counter) $229.95, Spec. see SG-4160B.
COUNTER SECTION: 10Hz-150MHz; *Max. Input*: ≤3V effective *Gate Time*: .1, 1sec. *Input Sensitivity: 35mV, 10Hz-200MHz. Input Impedance*: 1MΩ(HF), 50Ω(VHF). *Display*: 7-digit LEDs.

AM/FM STD SIGNAL GEN.

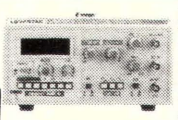
SG-4110A $1799.00, *Freq*: 0.1~110MHz; *Display*: 6-digit LED; Resolution: 100Hz (0.1~34.999MHz); 1KHz (35MHz~110MHz). *Accuracy*: <±($5x10^5$ ±1 count); *Output*: -19dBu~-99dBu, 1dB steps. *Impedance*: 50Ω VSWR 1.2; 100 preset frequency & store functions

AUDIO GENERATOR



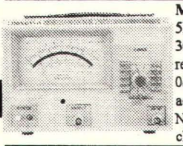
AG-2601A $124.95, 10Hz~1MHz in 5 ranges; *Output*: sinewave 0~$8V_{rms}$; square $10V_{p-p}$. *Output Imped*: 600 Ohm. *Distortion*: <0.05% 500Hz~50KHz; <0.5% 50KHz~500KHz.
AG-2603AD $229.95, with 6-digit, Int/Ext. Freq Counter, 10Hz~150MHz, *Output Control*: 0/-20/-40dB & Fine adjuster. Spec. see AG-2601A.

FUNCTION GENERATOR



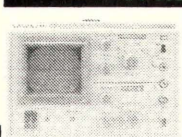
FG-2100A $169.95, 0.2Hz-2MHz in 7 ranges; sne, square, triangle, pulse & Ramp; *Output*: $5mV_{p-p}$-$20V_{p-p}$, 1% distortion. *VCF*: 0-10V/freq. to 1000:1.
FG-2102AD $229.95 see FG-2100A; 4-digit counter display, TTL & CMOS outputs, 30ppm ±1 count accuracy.
FG-2020B $159.00 0.5Hz-500KHz; Sine, Square, Triangle.
FG-2103 $329.95, Digital sweep generator, 0.5Hz-5MHz in 7 ranges. *Operating Mode*: sweep, AM, gated burst, VCG. *Freq. Counter*: Int. 0.5Hz-5MHz, Ext. 5HZ-10MHz.
FG-513 $769.95, 13 MHz, Microprocessor embedded dgital sweep; Sine, Square, Triangle, Pulse, Ramp, TTL & DC; ±(.01%+1dgt). *Freq. Counter & TCXO*: 5Hz-100MHz, 6.5 digits. x1/x20 attenuatn

AC MILLIVOLT METER



MV-3100A $159.95 wide band 5Hz~1MHz; 3 scales, mV, dB &dBm; 300μV~100V in 12 ranges, 10μV resolution; -70~40dB in 12 ranges, 0dB=1Vrms,0dBm=0.755V); ±3% accuracy; Input impedance 10MΩ; Noise <2%. **MV-3201B $309.95** dual channels, simultaneous measurement..

OSCILLOSCOPES



OS-7305B $249.00 DC~7MHz; 3" CRT; ***Horz:*** .25V/div; 10Hz~100KHz in 4 ranges; ***Vert:*** 10mV/div; Int. & Ext. Sync.; ***Input:*** 1MΩ/35pF.
OS-7010A $299.95 10MHz, 5"CRT, ***Horz:*** .2V/div; ***Vert:***10mV~10V /div.
OS-622G $389.95 20MHz, 2 CH/X-Y Alt trigger, trigger lock, hold OFF, TV syn., 8x10 div., 1mV/div., ***Horz:*** .2μs~.5s/div; ***Vert:*** 1mV~5V/div.
OS-653G $699.95 50MHz, 2 CH/delay sweep, Alt trigger, TV syn.
OS-6101G $1499.95 100MHz, 4ch/8 traces, delay sweep, cursor readout. *2 years warranty for OS-622G, OS-653G, & OS-6101G.*

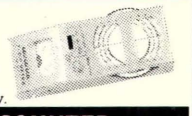
UHF ATTENUATORS

RT-8815U (50Ω) $299.00 / RT-8817U (75Ω) $299.00, 950MHz, 81dB, 0.5W max.; *Steps*: 1/2/3/5/10/20/20/20, 8 switches.
085E-2 (50Ω) $399.00 / 087E-2 (75Ω) $399.00, 950MHz, 81dB, 0.5W max.; *Steps*: 10dB+7.1dBx10, Electronic adjustment knob.

MICROPROCESSOR TRAINER

BGC-8088 $699.00, learn computer theory. Excellent for school & individual who want to learn about ROM, RAM, I/O ports, programming, & run a 8088 Microprocessor. An easy to understand step-by-step manual guides you to achieve your goal. 56-key keyboard, LCD display, RS-232, UART...

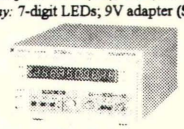
GRID DIP METER



DM-4061 $89.95 1.5-250MHz, 6 bands; 6 plug-in coils, 2 transistor, and 1 diode. *Modulation:*= 2KHz Sinewave. *Crystal Oscillator*: 1-15MHz. Wave absorption meter. 9VDC battery.

FREQUENCY COUNTER

FC-5250C $119.95 10Hz-220MHz: (HF)10Hz-20MHz, (VHF)10-200MHz. *GateTime*: .1, 1sec. *Max. Input*: $10V_{p-p}$. *Input Sensitivity*: 35mV/10Hz-200MHz *Input Imped.*: 1MΩ(HF), 50Ω(VHF). *Display*: 7-digit LEDs; 9V adapter **($6)**



FC-5260A $129.95
10Hz-600MHz. 7-digit LEDs.
FC-5270 $149.95
10Hz-1.2GHz; 8-digit LEDs.
FC-5600B $229.95
10Hz-600MHz; 10-digit LEDs.
FC-5700 $299.95 10Hz~1.3GHz; 10-digit LEDs. Period measure.

SIGNAL TRACER/INJECTOR

SE-6100 $134.95 (9VDC adapter, $6.0)
TRACER: Gain 60dB **maximum.** *Attenuation*: 0/20/40/60dB *Input Imped*: 100KΩ; *Meter:* Vu 100μA *Output Imped.*: 600Ω; *Speaker:* 8 Ω.
INJECTOR: =1KHz Squarewave; *Output Level:* Continuously variable 0 ~ $4.5V_{p-p}$; 9V battery/adaptor

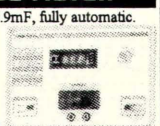
LCR METERS

MIC-4070D $179.95, *Induct.*: 0.1μ~200H, *Capacit.*: 0.1p~20mF, *Resist.*: 1mΩ~20MΩ, 2Ω range, Dissipation factor measurement, Zero adjust; Surface mount device (SMD) test probe: **LT-06 $21.95**

DIGITAL MULTIMETER

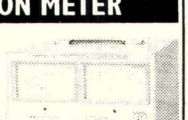
DMM-120 $24.95, 3½ digit, 600VDC, 2ADC 500VAC, 2MΩ, hFE/diode/continuity test.
DMM-123+Capacitance $44.95, 3½ digit, 600VDC/600VAC, 10ADC/AC, 2GΩ, 20μF, hFE/diode test, continuity beeper.
DMM-124+Cap.+Temp.+Freq Cntr $69.95, 3½ dig, 600VDC/500VAC, -58~752° F, 2GΩ, 20mF, 200KHz, 3φ phase/diode/continuity test.
DMM-125 $54.95, Autorange/Bargraph, 32MΩ, 600VDC/AC, 10ADC/AC, diode/continuity test.
MIC-35 $59.95, Autorange, 3½ digit LCD, 1000VDC/750VAC, 20MΩ, 20ADC/AC, diode/continuity check, data hold, free holster.
MIC-39 $129.95, Autorange/Bar Graph, True RMS, 3¾ digit, LCD, 40MΩ, 40μF, 1000VDC/750VAC, 20ADC/AC, 600KHz freq. cntr, data hold, drop-prove, sleep mode, memory, read functions, holster..

AUTO. CAPACITANCE METER



CM3300A $139.00 10 ranges, 99.9pF ~ 99.9mF, fully automatic. *Resolution:* 0.1pF lowest, 0.1% full scale. *Accuracy:*
0.5% of full scale ±1 digit to 99.9μF,
1% of full scale ±1 digit to 99.9μF.
Display: 3 digit LED.
Unit: pF, nF, μF, mF, Overrange indicators.

AUTO DISTORTION METER



DM-3104A $799.95
DISTORTION MEASURE
Range: 0.01% to 30%,
0.1/0.3/1/3/10/30% 6 ranges.
Freq: 400Hz±10%, 1KHz±10%(HPF).
Input: 3mV-100V; Ratio measure 20dB.
Auto. Freq. Switching Ranges:
Fundamental Freq. = (fo)±10%;
Fund. Rejection: >-80dB at (fo)±5%; >-70dB at (fo)±10%.
Harmonic Accuracy: ±0.5dB, 1.8(fo)-20KHz.
LEVEL MEASURE *Range:* 0 to 100V in .03/.1/.3/1/3/10/30/100V
Freq Response: ±0.5dB/20~50kHz, ±1dB/20~100kHz.
DM-3204 $1,599.00 dual channels; Spec see DM-3104A.

WOW-FLUTTER METER

WF-3103A $699.95 *Freq. Range*: 3KHz±10% JIS/CCIR; 3.15KHz±10% DIN. *Measuremt.*: .03/.1/.3/1/3% full scale. *Accuracy*: ±5% of full scall.
WF-3105A $799.95, digital display; *Function*: LIN/WOW/Flutter/WTD. *Freq Counter*: 10Hz-9.99MHz. *Indication*: CCIR/DIN/JIS.

CIRCLE 321 ON FREE INFORMATION CARD

Better Designs - Faster

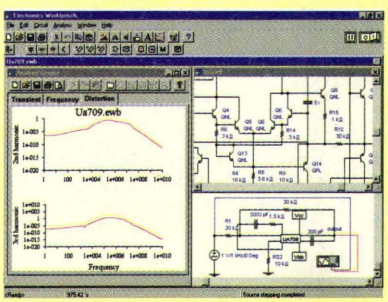
With the Personal Design Solution

The Design Solution Includes: Electronics Workbench Personal Edition + EWB Layout

Electronics Workbench® **Personal** Edition

Full-featured schematic capture and SPICE 3F circuit simulation!

The world's best selling circuit design software. With analog, digital and mixed A/D SPICE simulation, a full suite of analyses and over 4000 devices. Imports netlists. Seamlessly integrated with EWB Layout or exports to other popular PCB programs. Still the standard for power and ease of use. Still the same effective price.

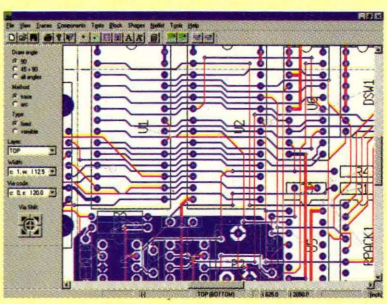


$299 Version 5

Electronics Workbench® **Personal** Edition **Layout**

Power-packed PCB layout with autorouting and real-time DRC!

EWB Layout is a powerful board layout package for producing high-quality, multi-layer printed circuit boards. Offering tight integration with our schematic capture program, you can incorporate board layout and design and quickly bring well-designed boards to production.



$299 Version 5

HIGH-END FEATURES	
TRUE MIXED ANALOG/DIGITAL	YES
FULLY INTERACTIVE SIMULATION	YES
PRO SCHEMATIC EDITOR	YES
HIERARCHICAL CIRCUITS	YES
VIRTUAL INSTRUMENTS	YES
ON-SCREEN GRAPHS	YES
ANALOG AND DIGITAL MODELS	OVER 4,000
FREE TECHNICAL SUPPORT	YES
DC OPERATING POINT	YES
AC FREQUENCY	YES
TRANSIENT	YES
FOURIER	YES
NOISE	YES
DISTORTION	YES

POWER-PACKED FEATURES	
AUTOROUTING	YES
REROUTE WHILE MOVE	YES
LAYERS	32 ROUTING LAYERS
BOARD SIZE	50" X 50"
LIBRARY SHAPES	OVER 3,500
BLIND AND BURIED VIAS	YES
EXTENSIVE OUTPUT	YES
SELECTIVE NET HIGHLIGHTING	YES
USER DEFINED PADS	YES
REAL TIME DESIGN RULE CHECK	YES
DENSITY HISTOGRAMS	YES
FREE TECHNICAL SUPPORT	YES

Join over 85,000 customers and find out why more circuit designers buy Electronics Workbench than any other circuit design tool.

30-DAY MONEY-BACK GUARANTEE

CALL FOR INFORMATION AND PRICING ON OUR PROFESSIONAL EDITION.

ELECTRONICS WORKBENCH Personal Edition	$299.00	BUY BOTH AND SAVE	PERSONAL DESIGN SOLUTION ~~$598.00~~ $548.00
EWB LAYOUT Personal Edition	$299.00		

CALL **800-263-5552**

For a free demo, visit our website at http://www.interactiv.com

INTERACTIVE IMAGE TECHNOLOGIES LTD., 908 Niagara Falls Boulevard, #068, North Tonawanda, New York 14120-2060 / Telephone 416-977-5550.

TRADEMARKS ARE PROPERTY OF THEIR RESPECTIVE HOLDERS. OFFER IS IN U.S. DOLLARS AND VALID ONLY IN THE UNITED STATES AND CANADA. ALL ORDERS SUBJECT TO $15 SHIPPING AND HANDLING CHARGE.

Fax: 416-977-1818 E-mail:ewb@interactiv.com
CompuServe: 71333,3435 / BBS:416-977-3540

INTERACTIVE

CIRCLE 126 ON FREE INFORMATION CARD